DOE/ID-10680
Revision 0
February 1999

U.S. Department of Energy
Idaho Operations Office

Comprehensive Remedial Investigation/Feasibility Study for the Central Facilities Area Operable Unit 4-13 at the Idaho National Engineering and Environmental Laboratory

Book 1

INEEL
IDAHO NATIONAL ENGINEERING & ENVIRONMENTAL LABORATORY

Comprehensive Remedial Investigation/Feasibility Study for the Central Facilities Area Operable Unit 4-13 at the Idaho National Engineering and Environmental Laboratory

DOE/ID-10680
Rev. 0
February 1999

Approved:

Steven H. McCormick

S. H. McCormick
WAG 4 PBS Manager

Jan 27, 1999

Date

ABSTRACT

This remedial investigation/feasibility study for Operable Unit 4-13 defines the potential risks at Waste Area Group 4, describes the background and regulatory history of the Idaho National Engineering and Environmental Laboratory, describes the field investigations, and characterizes the potential risks. The appendix includes the following tables; contaminant screening, facility analysis screening, ecological functional-group, analytical data, and risk calculation.

The assumptions for preparation of the feasibility study, preliminary remedial action objectives, and preliminary applicable or relevant and appropriate requirements are presented.

EXECUTIVE SUMMARY

This remedial investigation/feasibility study (RI/FS) for Waste Area Group (WAG) 4, Operable Unit (OU) 4-13, was prepared under the *Federal Facility Agreement and Consent Order* (FFA/CO) for the U.S. Department of Energy Idaho Operations Office (DOE-ID) at the Idaho National Engineering and Environmental Laboratory (INEEL).

Background of the INEEL

The INEEL is a government-owned reservation managed by the U.S. Department of Energy (DOE). It is located in southeast Idaho on the Eastern Snake River Plain (ESRP) and occupies an approximate area of 2,305 km^2 (890 mi^2). The U.S. Atomic Energy Commission established the National Reactor Testing Station, which later became the Idaho National Engineering Laboratory, in 1949. It was first used to build, test, and operate nuclear facilities. The U.S. Navy and the U.S. Army Air Corps used a portion of the site at the Central Facilities Area (CFA) from the early 1940s to the 1950s for gunnery and bombing ranges. The name was again changed to the INEEL in 1997 to reflect the emphasis on environmental operations.

Regulatory History

The INEEL was added to the U.S. Environmental Protection Agency's (EPA's) National Priorities List of Superfund sites on November 21, 1989 as published in the Federal Register (40 CFR 300). DOE-ID, EPA, and the State of Idaho signed the FFA/CO for the INEEL in December 1991. The goal of this agreement is to ensure that potential releases of hazardous substances to the environment from the INEEL are investigated and remediated in accordance with the *National Oil and Hazardous Substances Pollution Contingency Plan*. The FFA/CO divides the INEEL into 10 WAGs. CFA is designated as WAG 4, which currently consists of 52 potential release sites divided into 12 administrative OUs. This RI/FS encompasses all sites and OUs at WAG 4. The potential release sites include landfills, spills, ponds, storage tanks, drywells, and a sewage treatment plant. Potential contaminants at the sites include volatile organic compounds, semivolatile organic compounds, radionuclides, petroleum wastes, heavy metals, polychlorinated biphenyls, pesticides, and herbicides. Releases of hazardous materials may have occurred at CFA at locations other than the 52 release sites designated in the FFA/CO. All facilities at CFA were evaluated for releases and management control plans intended to prevent future releases.

Objectives

The objectives of this remedial investigation are to:

1. Identify data gaps that remain following the performance of previous investigations as identified in the *Work Plan for Waste Area*

Group 4 Operable Unit 4-13 Comprehensive Remedial Investigation/Feasibility Study (RI/FS) (McCormick et al. 1997).

2. Define the nature and extent of contamination at WAG 4.

3. Define contaminant transport mechanisms and develop exposure scenarios.

4. Determine the current and future cumulative and comprehensive risk posed by the contaminants of concern to human health and the environment.

5. Develop remedial action objectives and general response actions.

6. Develop and evaluate the appropriate remedial alternatives based on CERCLA criteria.

The first objective was addressed in the *Work Plan*. The second, third, and fourth objectives are addressed in this RI/BRA. The fifth and sixth objectives are addressed in the feasibility study.

Nature and Extent of Contamination

The 52 WAG 4 sites were evaluated and screened in the OU 4-13 RI/FS *Work Plan* (McCormick, et al., 1997). Sites retained for further evaluation and risk assessment are evaluated in this remedial investigation. The nature and extent of contamination for each site retained in the *Work Plan* was determined using data collected during the OU 4-13 field investigation, removal actions that occurred from 1995 through 1997, and other RI/FS and Track 2 investigations.

Sites Evaluated for Nature and Extent of Contamination and Risk Assessment

OU 4-02: CFA-13 Dry Well (South of CFA-640). This site consisted of a subsurface concrete structure that was excavated during the 1997 WAG 4 non-time critical removal action. All concrete and piping were removed and samples were collected from the excavation. Screening of these data for the BRA indicated that all potential contaminants at the site were below background and risk-based concentrations. CFA-13 was eliminated from further evaluation in the BRA.

OU 4-02: CFA-15 Dry Well (CFA-674). This site consisted of dry well near Building CFA-674. The dry well was excavated and disposed during the 1997 WAG 4 non-time critical removal action. Verification samples were collected in the excavation. Screening of these data for the BRA indicated that all potential contaminants are below background and risk-based concentrations. CFA-15 was eliminated from further evaluation in the BRA.

OU 4-05: CFA-04 Pond (CFA-674). This site consists of a shallow pond that was used for disposal of mercury contaminated wastes from a laboratory formerly located in building CFA-674. A time-critical removal action was performed at the pond in 1995 in which 218 m^3 (285 yd^3) of mercury-contaminated soil was removed and retorted. The pond and surrounding area was further evaluated in the OU 4-13 field investigation to define the extent of contamination in areas not included in the removal action. Samples were collected from the pond sediments, along the pipeline that ran from the building to the pond, from the staging area where retort equipment was used, and from geophysical anomalies near the pond. These data indicate that surface and subsurface soils in the pond bottom are contaminated with arsenic, mercury, U-234, and U-238. Consequently, CFA-04 will be evaluated for further remedial action.

OU 4-05: CFA-17 Fire Department Training Area, Bermed and CFA-47 Fire Station Chemical Disposal. These two sites are contiguous and were formerly used for fire training exercises. Wastewater containing unburned fuel and products of combustion were discharged to a small bermed area and an asphalt pad. A non-time critical removal action was performed in 1997 at the sites. Approximately 4,051 m^3 (5,298 yd^3) of petroleum-contaminated soil was removed down to top of basalt. All contaminants were removed from the surface and subsurface soils. Contaminants were detected in samples collected from soils directly on the basalt and it is assumed that contamination extends into the basalt to an unknown depth.

OU 4-06: CFA-06 Lead Shop (outside areas). This site consisted of the area surrounding Building CFA-687 where lead scrap was stored on the ground. A time-critical removal action was performed in 1996 to remove lead and arsenic-contaminated soil to a cleanup level of 400 mg/kg and 23 mg/kg, respectively. Approximately 153 m^3 (200 yd^3) of contaminated soil, asphalt, and lead were from the site. Verification data collected during the action were evaluated in the screening section of the BRA. The site was eliminated from further evaluation in the BRA as a result of the removal action.

OU 4-06: CFA-43 Lead Storage Area. This site consisted of a storage yard where lead scrap was stored on the ground. A time-critical removal action was performed in 1996 to remove lead and antimony-contaminated soil to a cleanup level of 400 mg/kg and 23 mg/kg, respectively. Approximately 304 m^3 (400 yd^3) of contaminated soil was removed. Verification data collected during the action were evaluated in the screening section of the BRA. The site was eliminated from further evaluation in the BRA as a result of the removal action.

OU 4-06: CFA-44 Spray Paint Booth Drain (CFA-654). This site consisted soil contamination from a former spray paint booth outlet from Building CFA-654. Wastewater from the drain included lead that discharged to the ground next to the building. A time-critical removal action was performed in 1996 to remove lead-contaminated soil to a cleanup level of 400 mg/kg, which was confirmed by verification data. These data were evaluated in the screening section of the BRA. The site was eliminated from further evaluation in the BRA as a result of data collected during the removal action.

OU 4-07: CFA-07 French Drain E/S (CFA-633). This site consisted of two french drains that received laboratory wastewater, located next to Building CFA-633. The drains were removed during a time-critical removal action performed concurrently with the Track 2 investigation in 1995. Verification data collected after removal of the drains indicated that lead, Cs-137, and Pu-238 are present at depths of 3.7 m (12 ft). Contamination is assumed to exist at CFA-07 from 3.7 to 7.1 m (12 to 23.5 ft) where basalt is encountered.

OU 4-07: CFA-12 French Drains (2) (CFA-690) (south drain only). This site consisted of two concrete french drains that received laboratory wastewater, located next to Building CFA-690. The drains were removed during a time-critical removal action performed concurrently with a Track 2 investigation in 1995. Verification data collected after removal of the drains indicated that pentachlorophenol, Am-241, Ba-133, Cs-137, and U-238 are present at a depth of 2.4 m (8.5 ft). Contamination is assumed to exist at the site from 2.4 to 5.6 m (8.5 to 18.5 ft) where basalt is encountered.

OU 4-08: CFA-08 Sewage Plant (CFA-691), Septic Tank (CFA-716) and Drainfield, and CFA-49 Hot Laundry Drain Pipe. These two sites consist of potential contaminant releases from the sewage treatment plant, structures, and the drainfield. The site was evaluated as a Track 2 investigation in 1995 and in 1997 as part of the OU 4-13 RI/FS. Samples collected in the vicinity of the treatment plant and along the drainfield discharge piping indicated no releases from plant structures or piping. Data collected from the drainfield indicate the presence of Cs-137, and Pu-239/240 in the surface sediments, however the entire interval from the surface to a depth of 5.5 m (18 ft) is assumed to be contaminated.

OU 4-09: CFA-10 Transformer Yard Oil Spills. This site consists of a yard where electrical transformers were stored and welding operations occurred. Data collected during the Track 2 investigation indicated the presence of lead in the surface soils. The depth of contamination is assumed to cover the yard to a depth of 3 m (10 ft).

OU 4-09: CFA-26 CFA-760 Pump Station Fuel Spill. This site consists of a potential release of 209,700 L (55,400 gal) of diesel fuel from an above-ground storage tank. Data collected during the Track 2 investigation indicated the presence of petroleum contamination in the subsurface, which resulted in the site being retained for evaluation in the RI/FS. Petroleum contamination is present in the basalt. The screening process utilized in the *Work Plan* resulted in elimination of all exposure pathways with the exception of the groundwater pathway. The groundwater pathway was further evaluated in the BRA, which resulted in elimination of the site from further evaluation.

OU 4-09: CFA-42 Tank Farm Pump Station Spills. This site consisted above-ground bulk storage fuel tanks and pump station where spills and leaks of unused fuel occurred. Petroleum contamination was discovered during a Track 2 investigation in 1995 and a time-critical removal action was performed in 1996. Approximately 1,797 m^3 (2,350 yd^3) of petroleum contaminated soil was removed. There was a possibility that more contamination was present and consequently an additional non-time-critical removal action was performed. An additional 4,921 m^3 (6,437 yd^3) of soil was removed from the site in addition to all buildings and tanks. Verification data collected at the site indicate that all contaminants in the soil above the basalt were removed, petroleum contamination is present in basalt.

OU 4-09: CFA-46 Cafeteria Oil Tank Spill (CFA-721). This site consisted of a leak from a 18,927 L (5,000 gal) underground diesel fuel tank. The tank was removed along with contaminated soil above the basalt in 1994. Verification samples and visual observations made during the removal indicated that fuel had leaked into the basalt and under Building CFA-668. The site was retained for further evaluation of the groundwater pathway in the BRA.

OU 4-11: CFA-05 Motor Pool Pond. This is the site of an unlined evaporation pond. The pond received waste from an equipment wash bay at the CFA Service Station from 1951 to 1985. Soil samples collected during the OU 4-11 RI/FS indicated the presence of radionuclides that do not pose unacceptable risk. The OU 4-11 Record of Decision determined that no further action would be required at the pond. However, evaluation of the groundwater pathway was deferred to the OU 4-13 RI/FS.

OU 4-13: CFA-51 Dry Well at North End of CFA-640. This site consisted of a small drywell located near Building CFA-640. The drywell was removed during the demolition of the building. Data collected at the time of removal were screened in the *Work Plan* and in the BRA. The results of the screening process indicate that all contaminants present are below background or risk-based concentrations. The site was therefore eliminated from further consideration in the BRA.

OU 4-13: CFA-52 Diesel Fuel UST (CFA-730) at Bldg. CFA-613 Bunkhouse. This site consisted of an 1,893 L (500 gal) underground storage tank. Data collected during tank removal in 1996 indicated that the tank had leaked. Data collected at the time of removal were screened in the *Work Plan* and in the BRA. The results of the screening process indicate that all contaminants present are below background or risk-based concentrations. The site was therefore retained for further consideration in the BRA for the groundwater pathway.

OU 4-13: Field Data Collection. The OU 4-13 field investigation involved collection of samples at the CFA-04 Pond, CFA-10 Transformer Yard, and CFA-08 Drainfield sites. The CFA-04 Pond is a site of mercury contaminated waste disposal from laboratory operations. Contaminated soil and calcine were removed from the pond sediments during a removal action in 1995. The sampling objectives at CFA-04 were intended to determine the extent of mercury contamination in and around the pond, if leaks from the pipe from building

CFA-674 to the pond were a source of contamination, if subsurface geophysical anomalies were sources of contamination, and the topographic features of the pond. Additional data were collected in 1998, which focused on the low areas of the pond and the windblown area. Mercury was detected at all the 88 locations. Data from three of the locations indicate that soils are RCRA hazardous for mercury. Data collected at these sites are representative of contamination in the sediments and surrounding areas.

The CFA-10 Transformer Oil Spills was used for welding operations. Process knowledge indicates that the yard site was not used to routinely dispose of waste, although some accidental spill of solid metals may have occurred. Data collected at the yard indicate the presence of lead in the soil above the EPA-screening level of 400 mg/kg.

The CFA-08 Drainfield was used to dispose of effluent from the sewage treatment plant. The drainfield received wastewater containing radiological and other wastes from the water treatment process at the plant. The sampling objectives at CFA-08 were intended to determine the extent of Cs-137 contamination in the sediments, the vertical and lateral extent of contamination at the alluvium-basalt interface adjacent to the drainfield, and the topographic features of the drainfield. Data collected at these sites are representative of contamination in the sediments and surrounding areas.

Data were collected in 1997 at CFA-13, CFA-15, CFA-17, CFA-42, and CFA-47 during a non-time critical removal action. Sites CFA-13 and –15 were drywells removed during the action. Sites CFA-17 and -47 were used for training fire personnel by burning petroleum and other chemicals. Soil contaminated with petroleum products was removed and treated or disposed. The sampling objectives were intended to determine the source and location of contamination. Contaminants present at the site were removed and treated or disposed down to the top of basalt. Samples collected at the soil-basalt interface indicate that petroleum contamination was released into the basalt.

Facilities Analysis

Facilities at CFA, the Fire Department Training Area, and the Weapons Range Complex were evaluated to determine the potential impact on cumulative risk at WAG 4 and the potential for future releases. Facilities (any building or structure) are grouped into the following general categories; craft shops, offices, general services, and laboratories. Management procedures used to mitigate potential releases to the environment were also evaluated. These procedures cover the following operations: safety analysis reports for nuclear facilities, RCRA contingency plans, spill avoidance and response plans, emergency plan implementation, tank management, hazardous waste, explosives safety, and other operations. The results of the analysis screen indicated that 19 tank sites were retained for further evaluation in the RI/FS. These tanks were modeled in this OU 4-13 RI/BRA using GWSCREEN to assess the potential for contamination to groundwater from potential leaks. The potential risk to groundwater from tank releases is outside the unacceptable risk range.

Baseline Risk Assessment Results

The baseline risk assessment (BRA) evaluated the potential adverse health effects on human and ecological receptors from potential contaminant releases. The BRA assesses potential risks for current and future land use scenarios.

The results of the human health BRA indicate that sites CFA-04, CFA-08, and CFA-10 pose unacceptable risk to human receptors. The contaminants and potential risks or hazard quotients are summarized below.

- CFA-04: the highest potential risk is posed by the presence of mercury in the pond (HQ=40) for a future resident at year 100.

- CFA-08: the highest potential risk is posed by the presence of Cs-137 in the drainfield surface soil (2E-04) for a current occupational worker.

- CFA-10: the primary contaminant at this site is lead for which no toxicity value exists. Lead has been measured in the surface soil in concentrations greater that 400 mg/kg, which is the EPA screening concentration.

The results of the ecological risk assessment indicate that sites CFA-04, CFA-08, CFA-10, CFA-43, and CFA-47 pose potential risks to ecological receptors. The contaminants and potential risks are summarized below.

- CFA-04: the hazard quotients for metals (aluminum, barium, cadmium, and mercury) are above 1,000.

- CFA-08: the hazard for barium is above 1,000.

- CFA-10: the hazard for cadmium and lead is above 1,000.

- CFA-43: the hazard for lead is above 1,000.

- CFA-47: the hazard for xylene is above 1,000.

Applicable or Relevant and Appropriate Requirements

The applicable or relevant and appropriate requirements are presented in Section 12. These ARARs were developed along with the development of the remedial alternatives.

CONTENTS

FIGURES

TABLES

ACRONYMS

AF	adjustment factor
ARAR	Applicable or Relevant and Appropriate Requirement
BAF	bioaccumulation factor
BBS	breeding bird survey
BETX	benezene, toluene, ethylbenzene, and xylenes
BLM	Bureau of Land Management
BRA	baseline risk assessment
BTEX	benezene, toluene, ethylbenezene, and xylene
BW	body weight
C2	Category 2
CEC	cation exchange capacity
CEL	Chemical Engineering Laboratory
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFA	Central Facilities Area
CFR	Code of Federal Regulations
CLP	contract lab program
COC	contaminant of concern
COPC	contaminant of potential concern
CRQL	contract required quantitation limit
CSM	conceptual site model
CVZIT	cumulative vadose zone interbed thickness
D&D	decontamination and decommissioning
DA	distribution area
DAR	document action request

DOE	U.S. Department of Energy
DOE-ID	U.S. Department of Energy Idaho Operations Office
EBSL	ecologically based screening levels
EPA	U.S. Environmental Protection Agency
ERA	ecological risk assessment
ERIS	environmental restoration information services
ESRP	Eastern Snake River Plain
FFA/CO	Federal Facilities Agreement/Consent Order
FSP	field sampling plan
GIS	geographic information system
HEAST	Health Effects Assessment Summary Tables
HI	hazard index
HQ	hazard quotient
HWD	hazardous waste determination
ICPP	Idaho Chemical Processing Plant
ICRP	International Committee on Radiological Protection
ICDF	INEEL CERCLA Disposal Facility
IDEMS	Integrated Data Environmental Management System
IDHW	State of Idaho Department of Health and Welfare
INEEL	Idaho National Engineering and Environmental Laboratory
INTEC	Idaho Nuclear Technology and Engineering Center
IRIS	Integrated Risk Information System
LMITCO	Lockheed Martin Idaho Technologies Company
LOAEL	lowest-observed-adverse-effect-level
MCL	maximum contaminant level

MCP	management control procedure
MF	modifying factor
NAS	National Academy of Science
NCP	National Contingency Plan
NOAEL	no-observed-adverse-effect-level
NTCRA	non-time critical removal action
OU	operable unit
PAH	polycyclic aromatic hydrocarbons
PCB	polychlorinated biphenyls
PRG	preliminary remediation goals
PUF	plant uptake factor
PVC	polyvinyl chloride
QCE	quantified critical exposure
QCEL	quantified critical exposure level
RAGS	Risk Assessment Guidance for Superfund
RBC	risk-based concentration
RESL	Radiological Environmental Sciences Laboratory
RfD	reference dose
RI	remedial investigation
RI/BRA	remedial investigation/baseline risk assessment
RI/FS	remedial investigation and feasibility study
RML	radiation measurements laboratory
RPD	relative percent difference
RTI	Research Triangle Institute
RWMC	Radioactive Waste Management Complex

SARA	Superfund Amendments and Reauthorization Act
SDGI	Screening and Data Gap Identification
SF	slope factor
SLERA	screening level ecological risk assessment
SRP	Snake River Plain
SRPA	Snake River Plain Aquifer
STP	sewage treatment plant
SVOC	semivolatile organic compound
T/E	threatened and/or endangered
TAN	Test Area North
TCC	typic camborthids–typic calciorthids
TCLP	toxicity characteristic leaching procedure
TIC	tentatively identified compounds
TNT	terphenyls and trinitrotoluene
TPH	total petroleum hydrocarbons
TRA	Test Reactor Area
TRV	toxicity reference value
TSCA	Toxic Substances Control Act
TSF	Technical Support Facility
UCL	upper confidence limit
UF	uncertainty factor
USFS	U.S. Forest Service
USFWS	U.S. Fish and Wildlife Service
USGS	U.S. Geological Survey
UST	underground storage tank

UTL	upper tolerance limit
UTM	Universal Transverse Meridian
VOC	volatile organic compound
VP	vapor pressure
WAG	Waste Area Group

Comprehensive Remedial Investigation/Feasibility Study for the Central Facilities Area Operable Unit 4-13 at the Idaho National Engineering and Environmental Laboratory

1. INTRODUCTION

The Department of Energy Idaho Operations Office (DOE-ID) is conducting a remedial investigation and feasibility study (RI/FS) for the 12 operable units (OUs) containing 52 potential release sites at the Central Facilities Area (CFA) of the Idaho National Engineering and Environmental Laboratory (INEEL) in southeastern Idaho. This investigation is being conducted in accordance with a *Federal Facility Agreement and Consent Order* (FFA/CO) among the Environmental Protection Agency (EPA) Region 10, the State of Idaho Department of Health and Welfare (IDHW), and DOE-ID under the *Comprehensive Environmental Response, Compensation, and Liability Act* (CERCLA).

CFA is included as Waste Area Group (WAG) 4 of the ten INEEL WAGs identified in the FFA/CO. The sites include landfills, spills, ponds, underground storage tanks (USTs), drywells, and a sewage treatment plant. The CFA release sites within each OU are illustrated in Appendix A. Detailed descriptions of each site are provided in Section 3.3 of the *Work Plan for Waste Area Group 4 Operable Unit 4-13 Comprehensive Remedial Investigation/Feasibility Study* (McCormick et al. 1997); hereafter referred to as the *RI/FS Work Plan*. The FFA/CO investigations and resulting decisions for the WAG 4 sites are summarized in Table 1-1.

1.1 Purpose and Objective

OU 4-13 is defined in the FFA/CO as the WAG 4 Comprehensive RI/FS. The purpose of this investigation is to fill the data gaps identified in the *RI/FS Work Plan* (McCormick et al. 1997), define the nature and extent of the contamination, and perform a comprehensive cumulative baseline risk assessment (BRA) of WAG 4.

The objectives of the comprehensive RI/FS are as follows:

1. Identify data gaps that remain following the performance of previous investigations as identified in the *RI/FS Work Plan* (McCormick et al. 1997), and develop and implement field investigations to fill the data gaps

2. Define the nature and extent of contamination at WAG 4

3. Define contaminant transport mechanisms and develop exposure scenarios

4. Determine the current and future cumulative comprehensive risk posed by the contaminants of concern to human health and the environment

5. Develop remedial action objectives and general response actions

6. Develop and evaluate the appropriate remedial alternatives based on the CERCLA criteria.

Table 1-1. Summary status of WAG 4 sites.

Operable Unit	Site Code	Site Name	FFA/CO Investigation	Documentation	Date	Direction by EPA, IDHW and DOE RPM
4-01	CFA-09	Central Gravel Pit	Interim action	ROD	6/2/92	No further action[d]
	CFA-11	French Drain (containing 5-in. shell) N. of CFA-633	Interim action	ROD	6/2/92	No further action
4-02	CFA-13	Dry Well (South of CFA-640)	Track-1	Statement[a]	2/29/96	No further action
	CFA-14	Two Dry Wells (CFA-665)	Track-1	Statement	2/29/96	No further action
	CFA-15	Dry Well (CFA-674)	Track-1	Statement	2/8/95	No further action
	CFA-16	Dry Well (South of CFA-682 Pumphouse)	Track-1	Statement	2/7/95	No further action
4-03	CFA-18	Fire Department Training Area, Oil Storage Tanks	Track-1	ROD[b]	10/10/95	No further action
	CFA-19	Gasoline Tanks (2) East of CFA-606	Track-1	ROD	10/10/95	No further action
	CFA-20	Fuel Oil Tank at CFA-609 (CFA-732)	Track-1	ROD	10/10/95	No further action
	CFA-21	Fuel Tank at Nevada Circle 1 (South by CFA-629)	Track-1	ROD	10/10/95	No further action
	CFA-22	Fuel Oil Tank at CFA-640	Track-2	Statement	3/12/97	No further action
	CFA-23	Fuel Oil Tank at CFA-641	Track-1	ROD	10/10/95	No further action
	CFA-24	Fuel Tank at Nevada Circle 2 (South by CFA-629)	Track-1	ROD	10/10/95	No further action
	CFA-25	Fuel Oil Tank at CFA-656 (North Side)	Track-1	ROD	10/10/95	No further action
	CFA-27	Fuel Oil Tank at CFA-669 (CFA-740)	Track-1	ROD	10/10/95	No further action
	CFA-28	Fuel Oil Tank at CFA-674 (West)	Track-1	ROD	10/10/95	No further action
	CFA-29	Waste Oil Tank at CFA-664, active	Track-1	ROD	10/10/95	No further action
	CFA-30	Waste Oil Tank at CFA-665, active	Track-1	ROD	10/10/95	No further action
	CFA-31	Waste Oil Tank at CFA-754, active	Track-1	ROD	10/10/95	No further action
	CFA-32	Fuel Tank at CFA-667 (North Side)	Track-1	ROD	10/10/95	No further action
	CFA-33	Fuel Tank at CFA-667 (South Side)	Track-1	ROD	10/10/95	No further action

Table 1-1. (continued).

Operable Unit		Site Code	Site Name	FFA/CO Investigation	Documentation	Date	Direction by EPA, IDHW and DOE RPM
		CFA-34	Diesel Tank at CFA-674 (South)	Track-1	ROD	10/10/95	No further action
		CFA-35	Sulfuric Acid Tank at CFA-674 (West Side)	Track-1	ROD	10/10/95	No further action
		CFA-36	Gasoline Tank at CFA-680	Track-1	ROD	10/10/95	No further action
		CFA-37	Diesel Tank at CFA-681 (South Side)	Track-1	ROD	10/10/95	No further action
		CFA-38	Fuel Oil Tank, CFA-683	Track-1	ROD	10/10/95	No further action
	*	CFA-45	Underground Storage Tank	Track-2	Statement	3/12/97	No further action
4-04		CFA-39	"Drum Dock" (CFA-771)	Track-1	Statement	10/26/94	No further action
		CFA-40	Returnable Drum Storage—South of CFA-601	Track-1	Statement	5/23/96	No further action
		CFA-41	Excess Drum Storage—South of CFA-674	Track-1	Statement	5/23/96	No further action
4-05		CFA-04	Pond (CFA-674)	Track-2	Statement	3/12/97	RI/FS[e]
		CFA-17	Fire Department Training Area, bermed	Track-2	Statement	3/12/97	RI/FS (BRA)[e]
	*	CFA-47	Fire Station Chemical Disposal	Track-2	Statement	3/12/97	RI/FS (BRA)[e]
	*	CFA-50	Shallow Well East of CFA-654	Track-1/ Track-2	Statement	3/12/97	No further action
4-06		CFA-06	Lead Shop (outside areas)	Track-2	Statement	5/23/96	RI/FS/Removal action
		CFA-43	Lead Storage Area	Track-2	Statement	5/23/96	RI/FS/Removal action
		CFA-44	Spray Paint Booth Drain (CFA-654)	Track-2	Statement	5/23/96	RI/FS
4-07		CFA-07	French Drains E/S (CFA-633)	Track-1/ Track-2	Statement	3/12/97	RI/FS(BRA)[e]
		CFA-12	French Drains (2) (CFA-690)	Track-1/ Track-2	Statement	3/12/97	RI/FS(BRA)[e] (south drain only) No further action (north drain)
	*	CFA-48	Chemical Washout South of CFA-633	Track-2	Statement	3/12/97	No further action
4-08		CFA-08	Sewage Plant (CFA-691), Septic Tanks (CFA-716) and Drainfield	Track-2	Statement	5/23/96	RI/FS

Table 1-1. (continued).

Operable Unit		Site Code	Site Name	FFA/CO Investigation	Documentation	Date	Direction by EPA, IDHW and DOE RPM
	*	CFA-49	Hot Laundry Drain Pipe	Track-2	Statement	5/23/96	RI/FS
4-09		CFA-10	Transformer Yard Oil Spills	Track-2	Statement	3/12/97	RI/FS (BRA)[e]
		CFA-26	CFA-760 Pump Station Fuel Spill	Track-2	Statement	3/12/97	RI/FS (BRA)[e]
		CFA-42	Tank Farm Pump Station Spills	Track-2	Statement	3/12/97	RI/FS (BRA)[e]
	*	CFA-46	Cafeteria Oil Tank Spill (CFA-721)	Track-2	Statement	3/12/97	RI/FS (BRA)[e]
4-10		CFA-01	Landfill I	Track-2	Statement	10/20/93	OU 4-12 RI/FS
4-11		CFA-05	Motor Pool Pond	RI/FS	ROD	12/31/92	No further action
4-12		CFA-01	Landfill I	RI/FS	ROD	10/10/95	Remedial action
		CFA-02	Landfill II	RI/FS	ROD	10/10/95	Remedial action
		CFA-03	Landfill III	RI/FS	ROD	10/10/95	Remedial action
4-13	*	CFA-51	Drywell at North end of CFA-640	RI/FS	New Site Identification[c]	4/96	RI/FS (BRA)[e]
	*	CFA-52	Diesel Fuel UST (CFA-730) at Bldg CFA-613 Bunkhouse	RI/FS	New Site Identification	4/96	RI/FS (BRA)[e]

* These sites were added to the FFA/CO using the new site identification process.

a. A decision statement regarding future action at a Track 1 or Track 2 site.

b. The final decision specifying the selected remedy at a site.

c. A process for adding potential release sites to the FFA/CO.

d. Based on risk.

e. Recommended for further evaluation in the RI/FS. Sites designated "BRA" will only be evaluated in the OU 4-13 RI BRA.

The first objective was addressed in the *RI/FS Work Plan* (McCormick et al. 1997). Section 3.2 of the *RI/FS Work Plan* (McCormick et al. 1997) documents the screening and data gap identification process that was performed. This process was used to screen sites and contaminants, and identify data gaps to be filled during the RI. The second, third, and fourth objectives are addressed in this baseline risk assessment (BRA). The fifth and sixth objectives are addressed in the FS.

1.2 Site Background and Regulatory History

The INEEL is a government-owned reservation managed by the U.S. Department of Energy (DOE). The eastern boundary of the INEEL is located 52 km (32 mi) west of Idaho Falls, Idaho. The INEEL site occupies approximately 2,305 km^2 (890 mi^2) of the northwestern portion of the Eastern Snake River Plain (ESRP) in southeast Idaho. The Site is nearly 62 km (39 mi) long from north to south (extreme latitudes are 43° 26′ and 44° 01′ N) and approximately 57 km (36 mi) at its broadest southern portion (extreme longitudes are 112° 28′ and 113° 9′ W). The INEEL includes portions of five Idaho counties (i.e., Bingham, Bonneville, Butte, Clark, and Jefferson) and lies within Townships 2 to 8 N and Ranges 28 to 34 E Boise meridian. Figure 1-1 illustrates the INEEL configuration and some of its major facilities.

The INEEL lands are within the aboriginal land area of the Shoshone-Bannock Tribes. The Tribes have used the land and waters within and surrounding the INEEL for fishing, hunting, plant gathering, medicinal, religious, ceremonial, and other cultural uses since time immemorial. These lands and waters have provided the Tribes their home and sustained their way of life. The record of the Tribes' aboriginal presence at the INEEL is considerable, and DOE has documented an excess of 1,500 prehistoric and historic archeological sites.

1.2.1 History of the INEEL

A portion of the current INEEL site was first used during World War II as a gunnery range for the U.S. Navy, and as an aerial gunnery range for the U.S. Army Air Corps. The former Navy administration shop, warehouse, and housing area are part of what is now known as CFA. The INEEL site was originally established in 1949 as the National Reactor Testing Station by the U.S. Atomic Energy Commission as a site for building, testing, and operating various nuclear reactors, fuel processing plants, and support facilities. In 1974, the NRTS was redesignated as the Idaho National Engineering Laboratory to reflect the broad scope of engineering activities conducted at the site. The name was again changed to the INEEL in 1997 to reflect the emphasis on environmental work.

Prior to the establishment of the National Reactor Testing Station, the land on which the INEEL is located was controlled by the U.S. Bureau of Land Management (BLM). The land was withdrawn from the public domain through a series of public land orders in 1946, 1949, and 1950. Until then, the area was used primarily as rangeland. Approximately 1,217 to 1,424 km (470 to 550 mi^2) around the perimeter of the INEEL are open to grazing through permits administered through the BLM; however, since 1957 the central portion of the INEEL, which is approximately 1,385 km^2 (535 mi^2) has been maintained as a grazing exclusion area.

The remainder of the INEEL has been excluded from public access and is relatively undisturbed. The DOE has established the INEEL as a National Environmental Research Park, making it one of two such parks in the nation that allow comparative studies of ecological processes in sagebrush-steppe ecosystems.

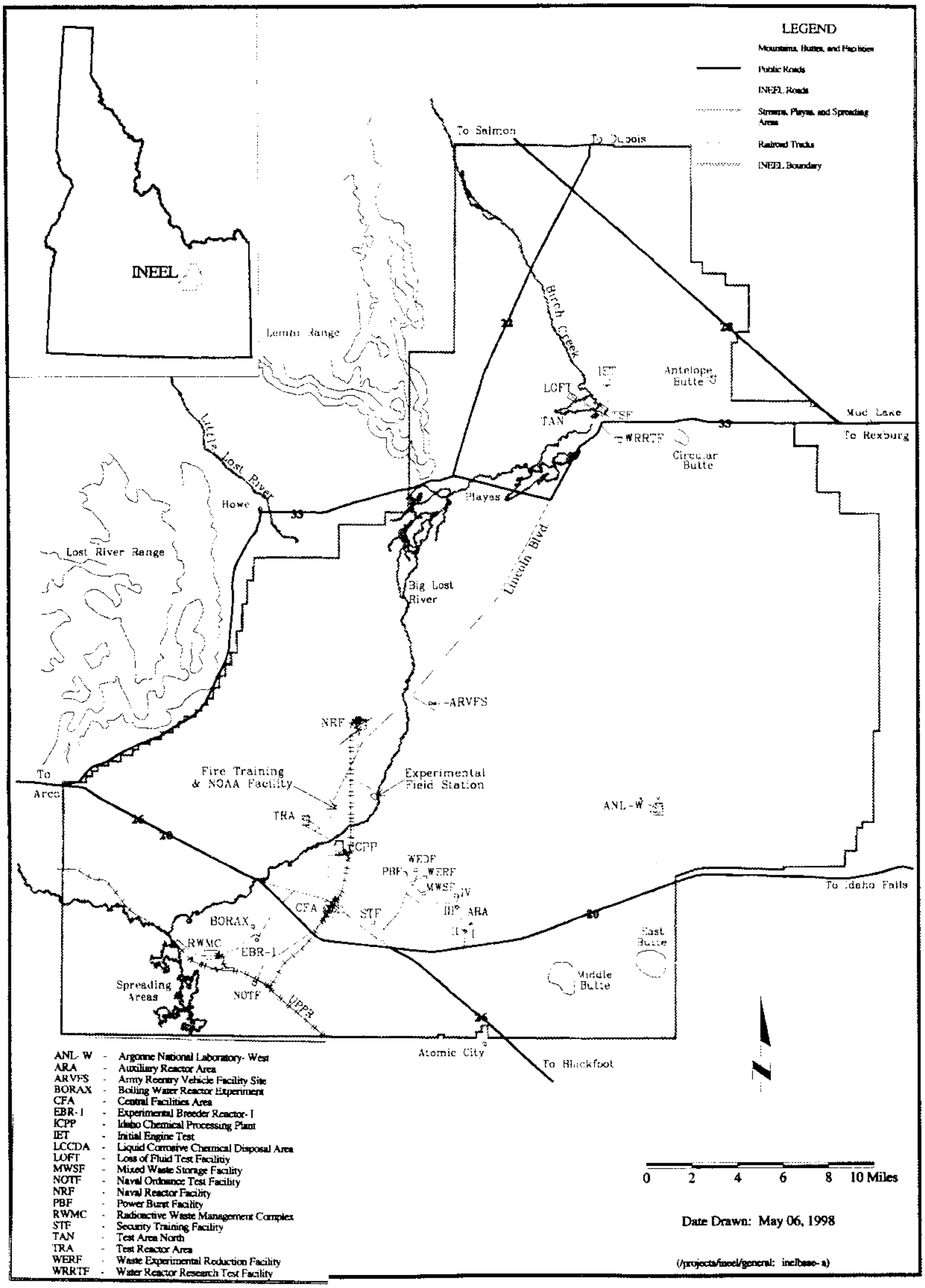


Figure 1-1. Location INEEL site map showing major facilities.

1.2.2 Regulatory History

The INEEL was added to the U.S. Environmental Protection Agency's (EPA's) National Priorities List of Superfund sites on November 21, 1989 as published in the Federal Register (54 FR 48184). A FFA/CO for the INEEL was signed by DOE-ID, EPA, and the State of Idaho in December 1991 (DOE 1991). The goal of this agreement is to ensure that potential or actual INEEL releases of hazardous substances to the environment are thoroughly investigated in accordance with the *National Oil and Hazardous Substances Pollution Contingency Plan* (NCP), and that appropriate response actions are taken as necessary to protect human health and the environment.

1.3 Overview of WAG 4

CFA is located in the south-central portion of the INEEL approximately 93 km (50 mi) from the cities of Idaho Falls and Pocatello (refer to Figure 1-1). The original facilities at CFA were built in the 1940s and 1950s to house the U.S. Navy's gunnery range personnel. The facilities have been modified over the years to fit the changing needs of the INEEL and now provide craft, office, service, and laboratory space. Approximately 820 people routinely work at CFA.

It is possible that historical releases have occurred at CFA that may not have been designated as release sites. Also, because CFA is an operational facility, the possibility exists that future operations could result in spills or other impacts to human health or the environment. All facilities at CFA were therefore evaluated (in the *RI/FS Work Plan*) for past and potential future releases to determine whether or not site contamination had occurred that was not identified in the FFA/CO, and to determine if a potential unacceptable risk associated with a facility exists. A screening process was implemented to eliminate or retain a facility for further evaluation. Nineteen facilities were retained as a result of this process (see Attachment III, DOE 1997b).

1.4 Report Organization

The organization of this report generally follows the suggested format provided in *EPA Guidance* (EPA 1988). This report summarizes previous reports and provides new information obtained during the field investigations and the results of the Comprehensive BRA. This report is sectioned as follows:

- Section 1 summarizes CFA investigations at WAG 4 through the completion of this RI/BRA
- Section 2 describes the physical setting of WAG 4
- Section 3 discusses the OU 4-13 field investigations, and removal actions
- Section 4 discusses the analytical data, the nature and extent of contamination at each site, and analyzes CFA facilities
- Section 5 discusses deviations from the *RI/FS Work Plan* (McCormick et al. 1997)
- Section 6 presents the BRA for individual sites and a comprehensive risk assessment for the entire WAG 4
- Section 7 presents the ecological risk evaluation for WAG 4

- Section 8 presents risk management considerations and conclusions based on the comprehensive evaluation of the BRA and sampling data.

- Section 9 presents the development of remedial action objectives and general response actions.

- Section 10 presents the development alternatives.

- Section 11 presents the screening and alternatives.

- Section 12 presents the detailed analysis of alternatives.

The appendices include OU 4-13 analytical data, documentation to support the human health and ecological risk assessments, a guide to locate the information required for a Natural Resources Damage Preassessment Screening, and cost estimates for cleanup.

1.5 References

40 CFR 300, July 1997, "National Oil and Hazardous Substances Pollution Contingency Plan," *Code of Federal Regulations*, U.S. Government Printing Office.

54 FR 48184, 40 CFR 300, July 1997, "National Priorities List of Superfund Sites," *Code of Federal Regulations*, Final Rule, U.S. Government Printing Office.

DOE-ID, 1991, *Federal Facility Agreement and Consent Order for the Idaho National Engineering Laboratory*, 1088-06-29-120, U.S. Department of Energy, Idaho Field Office, U.S. Environmental Protection Agency, Region 10; State of Idaho, Department of Health and Welfare, December.

Environmental Protection Agency, 1988, *Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA*, Interim Final, EPA/540/G-89/0004, October 1988.

McCormick, S. H., et al., 1997, *Work Plan for Waste Area Group 4, Operable Unit 4-13 Comprehensive Remedial Investigation/Feasibility Study*, DOE/ID-10550, March 1997.

U.S. Environmental Protection Agency, "Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA or Superfund)," Title 42, Chapter 103, *United States Code*, s/s 9601 et seq., 1980.

2. PHYSICAL CHARACTERISTICS OF WASTE AREA GROUP 4

This section describes the physical geography, meteorology, geology, hydrology, demography, and ecology of WAG 4. Regional and local characteristics are also discussed.

2.1 Physiography

The INEEL, located on the northern edge of the Eastern Snake River Plain (ESRP), has an 80 to 112 km (50 to 70 mi) wide, northeastern-trending basin extending from the vicinity of Bliss, Idaho on the southwest to the Yellowstone Plateau on the northeast. Three mountain ranges end at the northern and northwestern boundaries of the INEEL: the Lost River Range, the Lemhi Range, and the Beaverhead Mountains of the Bitterroot Range. There are 1,188 to 1,306 m (3,960 to 4,620 ft) of relief between the ranges and the relatively flat plain (Hull 1989). Saddle Mountain Peak, near the southern end of the Lemhi Range, reaches an altitude of 3,243 m (10,810 ft) and is the highest point in the immediate area of the INEEL. The physiographic features of the INEEL area are shown in Figure 2-1.

The ESRP slopes upward from an elevation of approximately 750 m (2,500 ft) at the Oregon border, to over 1,500 m (5,000 ft) at Ashton, northeast of the INEEL. The ESRP is composed of two structurally dissimilar segments, with the division occurring between the towns of Bliss and Twin Falls, Idaho. East of Twin Falls, the Snake River has cut a valley through Tertiary basin fill sediments and interbedded volcanic rocks. The stream drainage is well developed, except in a few areas covered by recent thin basalt flows. The complexion of the plain changes as the Snake River flows further west through a vertical-walled canyon through thick sequences of Quaternary basalt with few interbedded sedimentary deposits.

The portion of the ESRP occupied by the INEEL may be divided into three minor physical provinces. The first province is a central trough, often referred to as the Pioneer Basin, that extends to the northeast through the INEEL. Two flanking slopes descend to the trough, one from the mountains to the northwest and the other from a broad ridge on the plain to the southeast. The slopes on the northwestern flank of the trough are mainly alluvial fans originating from sediments of Birch Creek and the Little Lost River. Also forming these gentle slopes are basalt flows that have spread onto the plain. The landforms on the southeast flank of the trough are formed by basalt flows, which spread from an eruption zone that extends northeastward from Cedar Butte (Figure 2-1). The lavas that erupted along this zone built up a broad topographic swell directing the Snake River to its current course along the southern and southeastern edges of the plain (Figure 2-2). This topographic swell effectively separates the drainage from mountain ranges northwest of the INEEL from the Snake River.

The central lowland of the INEEL broadens to the northeast and joins the extensive Mud Lake Basin. The Big and Little Lost Rivers and Birch Creek drain into this trough from valleys between the mountains to the north and west. The intermittently flowing waters of the Big Lost River have formed a flood plain in this trough, consisting primarily of fine sands, silts, and clays. The streams flow to the Lost River and Birch Creek Sinks and form a system of playa depressions in the west-central portion of the INEEL.

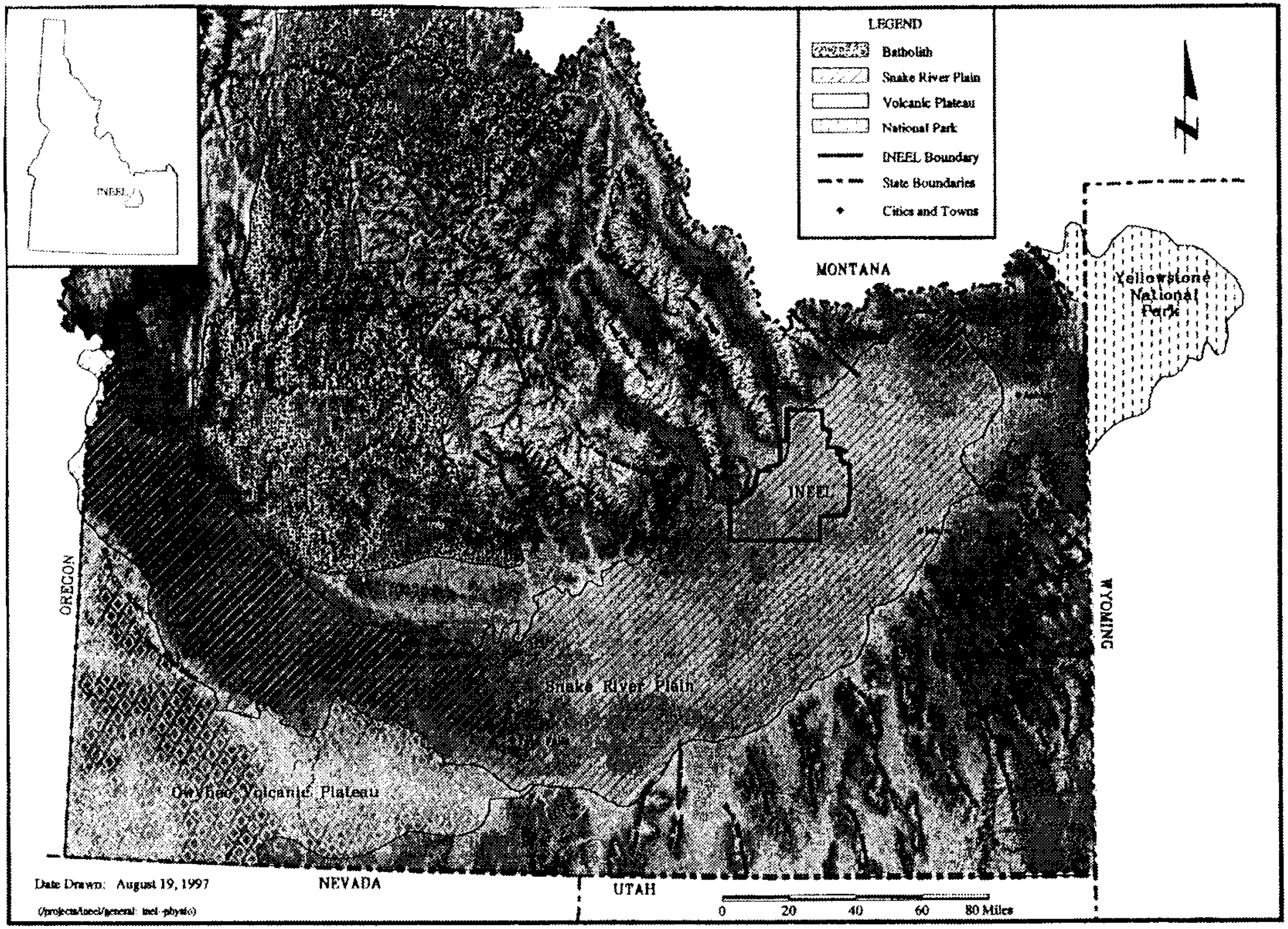


Figure 2-1. Physiographic features of the INEEL area.

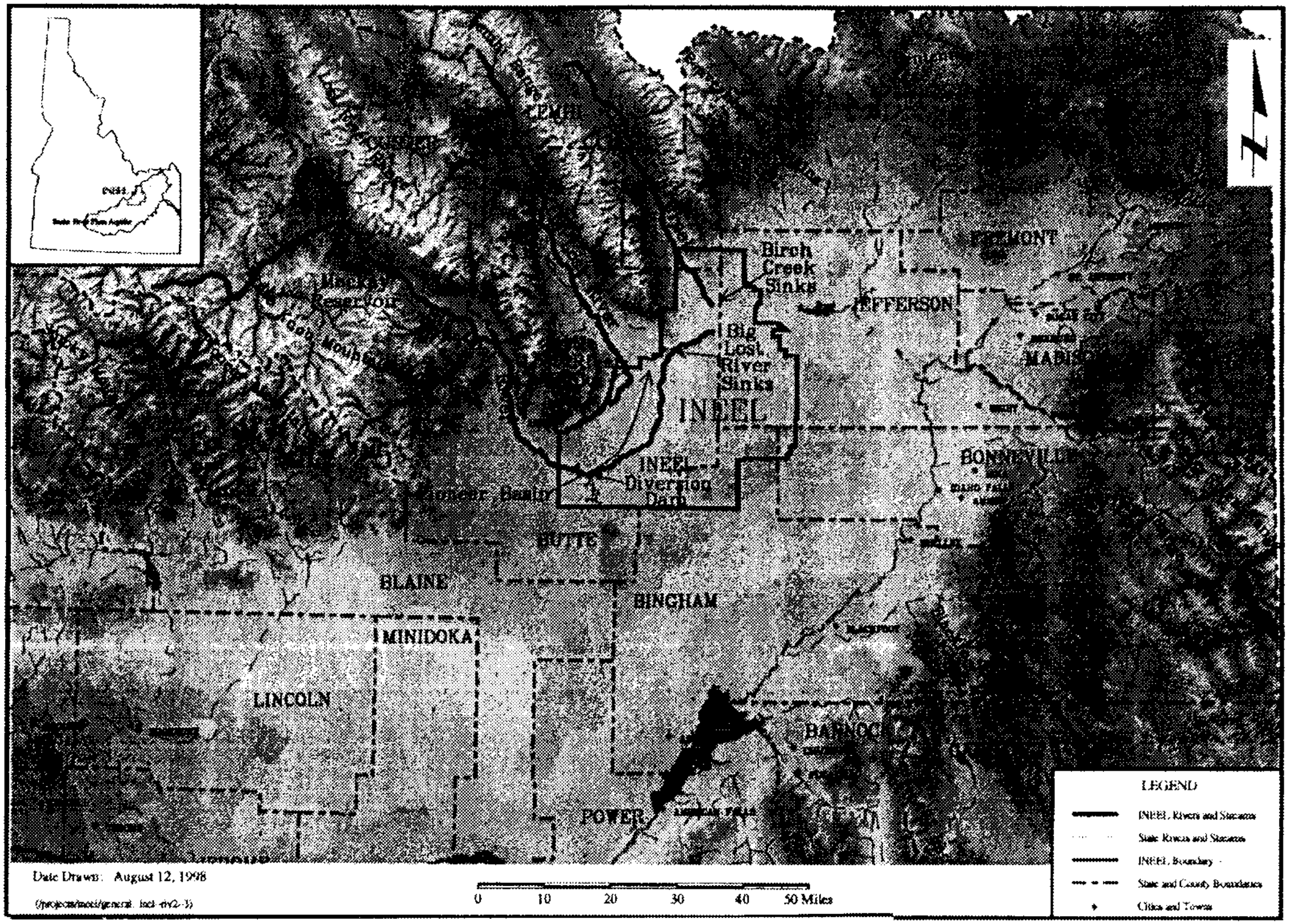


Figure 2-2. Index map of the Western Snake River Plain (modified from Hackett et al. 1982).

2.2 Meteorology

Atmospheric transport of contaminants is controlled by the following physical parameters: particle size, climate, local meteorology, local topography, large structures or buildings onsite, and contaminant source strength. This section describes the physical parameters that are necessary to evaluate environmental and human health impacts from atmospheric transportation of contaminants from CFA.

2.2.1 Climate

In 1949, the U.S. Weather Bureau, under agreement with DOE, established a complete Weather Bureau Station at the INEEL (then the NRTS). Wind direction, speed, temperature, and precipitation have been continuously recorded at CFA since approximately 1949. Most of the information presented in this section is summarized from the 2nd edition of *Climatography of the Idaho National Engineering Laboratory* (Clawson, Start, and Ricks 1989), which compiles results of weather recordings from 1949 to 1988. Further details of the INEEL's meteorology can be obtained from this reference. The longest and most complete record of meteorological observations at the INEEL is kept at the CFA station.

The climate at the INEEL is influenced by the regional topography and upper-level wind patterns over North America. The Rocky Mountains and the ESRP help to create a semi-arid climate with an average summer day-time maximum temperature of 28°C (83°F) and an average winter day time maximum temperature of -0.5°C (31°F). Infrequent cloud cover over the region allows intense solar heating of the ground surface during the day, and the low absolute humidity allows significant radiant cooling at night. These factors create large temperature fluctuations near the ground (Bowman et al. 1984). During a 22-year period of meteorological records (1954 through 1976), temperature extremes at the INEEL have varied from a low of -45°C (-49°F) in January to a high of 39°C (103°F) in July.

2.2.2 Local Meteorology

The average relative humidity at the INEEL ranges from a monthly average minimum of 15% in August to a monthly average maximum of 81% in February and December. The relative humidity is directly related to diurnal temperature fluctuations. Relative humidity reaches a maximum just before sunrise (the time of lowest temperature) and a minimum in the late afternoon (time of maximum daily temperature) (Van Deusen and Trout 1990).

Average annual precipitation at the INEEL is 21.5 cm (8.5 in.). The highest precipitation rates occur during the months of May and June and the lowest precipitation rates occur in July. Snowfall at the INEEL ranges from a low of approximately 30.5 cm (12 in.) per year to a high of approximately 127 cm (40 in.) per year, with an annual average of 66 cm (26 in.). Normal winter snowfall occurs from November through April, although occasional snowstorms occur in May, June, and October (Van Deusen and Trout 1990).

A statistical analysis of precipitation data from CFA for the period 1950 through 1990 was performed to determine estimates for the 25- and 100-year maximum 24-hour precipitation amounts and the 25- and 100-year maximum snow depths (Sagendorf 1991). Results from this study indicate 3.43 cm (1.35 in.) of precipitation for a 25-year, 24-hour storm event, and 4.1 cm (1.6 in.) of precipitation for a 100-year, 24-hour storm event. The expected 25-year maximum snow depth is 57.4 cm (22.6 in.) and the 100-year maximum snow depth is 77.8 cm (30.6 in.).

Potential annual evaporation from saturated ground surface at the INEEL is approximately 91 cm (36 in.). Eighty percent of this evaporation occurs between May and October. During the warmest month (July), the potential daily evaporation rate is approximately 0.63 cm/day (0.25 in./day). During the coldest months (December through February), evaporation is low and may be insignificant. Actual evapotranspiration by native vegetation on the INEEL parallels the total annual precipitation input.

The local meteorology is influenced by local topography, mountain ranges, and large-scale weather systems. The orientation of the bordering mountain ranges and the general orientation of the ESRP play an important role in determining the wind regime. The INEEL is in the belt of prevailing westerly winds, which are normally channeled across the ESRP. This channeling usually produces a west-southwest or southwest wind. When the prevailing westerlies at the gradient level (approximately 1,500 m [5,000 ft] above land surface) are strong, the winds channeled across the ESRP between the mountains become very strong. Some of the highest wind speeds at the INEEL have been observed under these meteorological conditions. The greatest frequency of high winds occur mainly in the spring. Average monthly wind speeds up to 6 m (20 ft) in height are highest in the month of April with speeds of 15 km/h (9 mph) at CFA. The highest wind speeds recorded at CFA and Test Area North (TAN) are 108 km/h (67 mph) and 100 km/h (62 mph), respectively.

The INEEL is subject to severe weather episodes throughout the year. Thunderstorms are observed mostly during the spring and summer. An average of two to three thunderstorms occur during June, July, and August. Thunderstorms may be accompanied by strong, gusty winds that may produce local dust storms. Precipitation from thunderstorms at the INEEL is generally light. Dust devils are also common in the region. Dust devils can entrain dust and pebbles and transport them over short distances. This usually occurs on warm sunny days with little or no wind. The dust cloud may be several hundred yards in diameter and extend several hundred feet in the air.

The vertical temperature and humidity profiles in the atmosphere determine the atmospheric stability. Stable atmospheres are characterized by low levels of turbulence and less vertical mixing. This results in higher ground level concentrations of emitted contaminants. The stability parameters at the INEEL range from extremely stable to very unstable. The stable conditions occur mostly at night during strong radiant cooling. Unstable conditions can occur during the day when there is strong solar heating of the surface layer or whenever a synoptic scale disturbance passes over the region.

2.3 Geology

The geology of the INEEL is strongly influenced by volcanic and seismic processes which have created the ESRP and the surrounding basin and range structures. The current theory of the evolution of the ESRP volcanic province is that it was formed in response to movement of the North American continent over a deep-seated plume of anomalously hot mantle rocks (hotspot) that now resides beneath Yellowstone National Park (Armstrong et al. 1975, Pierce and Morgan 1992). Movement of the continent and northeast-directed extension of the crust caused both the ESRP and the northeastern Basin-and-Range province to develop during the past 17 million years. During that time, extension of the crust has produced northwest trending normal faults and mountain ranges, while volcanic activity associated with the Yellowstone Plateau hotspot has produced a belt of calderas along the ESRP. The Yellowstone hotspot was beneath the INEEL area approximately 6.5 to 4.3 million years ago and produced the volcanic fields shown in Figure 2-3. The Pleistocene calderas of the Yellowstone Plateau formed from 2.1 to 0.6 million years ago, and strong geothermal activity continues as the hotspot still resides beneath the Yellowstone Plateau.

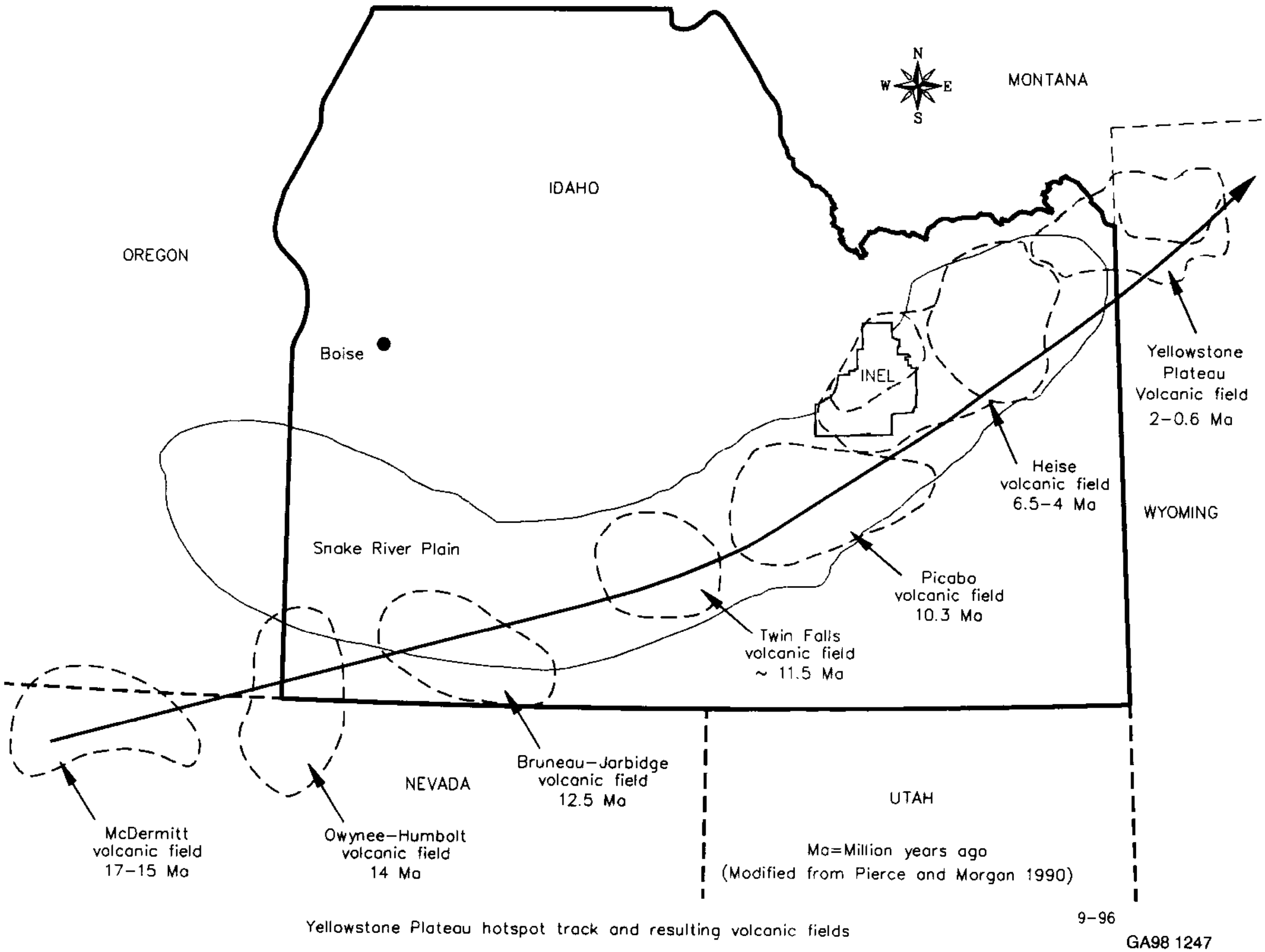


Figure 2-3. Yellowstone Plateau hotspot track and resulting volcanic fields (AC3090).

2.3.1 Regional Geology

The Lemhi, Beaverhead, and Lost River mountain ranges are located north of the ESRP (refer to Figure 2-2). These ranges are composed of Paleozoic sedimentary rocks that were folded and faulted along the northeastward-trending axis during late Cretaceous or early Tertiary Laramide Orogeny. Many of these Paleozoic rocks dip toward the axis of the ESRP (Nace et al. 1975). Within the margins of the ESRP, Miocene and younger volcanic rocks rest unconformably on deformed or tilted sedimentary and plutonic rocks ranging in age from Precambrian to Mesozoic and on faulted remnants of middle to late Eocene "calcalkalic" volcanic rocks (Leeman 1982).

Much of the INEEL is covered by unconsolidated surficial deposits of various ages and origins. A wide band of Quaternary alluvium extends along the course of the Big Lost River from the southwestern corner of INEEL to the Lost River Sinks in the north-central portion of the INEEL. Lacustrine (lake) deposits of clays, silts, and sands deposited in Pleistocene Lake Terreton occur in the northern part of INEEL. Wind deposited silts or loess with thicknesses of up to approximately 6 m (20 ft) cover much of the basalt bedrock at the INEEL. Beach sands deposited at the high stand of Lake Terreton were reworked by winds in the late Pleistocene and Holocene time and form large dune fields (eolian deposits) in the northeastern portion of the INEEL (Scott 1982). Large alluvial fans occur in limited areas along the northwest and west boundaries of the INEEL at the base of the Arco hills and the Lemhi Range.

Because of their mechanism of eruption, flow from the source vents, and cooling after emplacement the basalt lava flows possess predictable vertical and horizontal facies distributions (Figure 2-4). From bottom to top, basalt lava flows are typically composed of a basal rubble zone, a lower vesicular zone, a massive columnar jointed zone, an upper vesicular and fissured zone, and a cap of platy jointed crust. From source to distal end, the flows grade from thin, cavernous, platy flows (shelly pahoehoe) with interlayered pyroclastic material, to thick units with the vertical zoning described above. In the medial and distal areas, deflation depressions or pits are common and fissures in the broken crust are numerous. Many of the lava flows (especially the larger ones) on the ESRP are fed by lava tubes that commonly drain in the late stages of eruption, leaving long openings in the flows. In the lava flow sequence beneath the ESRP and the INEEL, the basal rubble zones, cooling fractures, fissures, lava tubes, vesicles, cavernous shelly pahoehoe, and pyroclastic zones furnish the porosity and permeability for the storage and transport of water in the aquifer. All of these features are primary (i.e., they were formed during emplacement of the rocks) except the polygonal cooling fractures.

Because of the concentration of volcanic activity along the Axial Volcanic Zone (Figure 2-5) and along volcanic rift zones, these areas tend to be constructional highlands that receive less sediment than other areas. Thus, the total thickness of sediments in the basalt and sediment sequence tends to be greater near the plain margins (Whitehead 1986) and between volcanic rift zones. In fact, many of the drill holes along the Axial Volcanic Zone show that no interbeds occur in that area. The combination of sparse interbeds, and abundance of shelly pahoehoe and pyroclastic material along the Axial Volcanic Zone suggest a thicker and more actively moving aquifer there than elsewhere on the ESRP.

In conclusion, Bartholomay (1990) found that the mineralogy of sedimentary interbeds in the Radioactive Waste Management Complex (RWMC), Test Reactor Area (TRA), and Idaho Nuclear Technology and Engineering Center (INTEC, formerly the Idaho Chemical Processing Plant [ICPP]) areas correlate with sediments of the Big Lost River drainage, and the mineralogy of sedimentary interbeds at TAN correlates with surficial deposits of the Birch Creek drainage. These correlations suggest that the sedimentary interbeds probably were deposited in a depositional environment similar to present-day conditions.

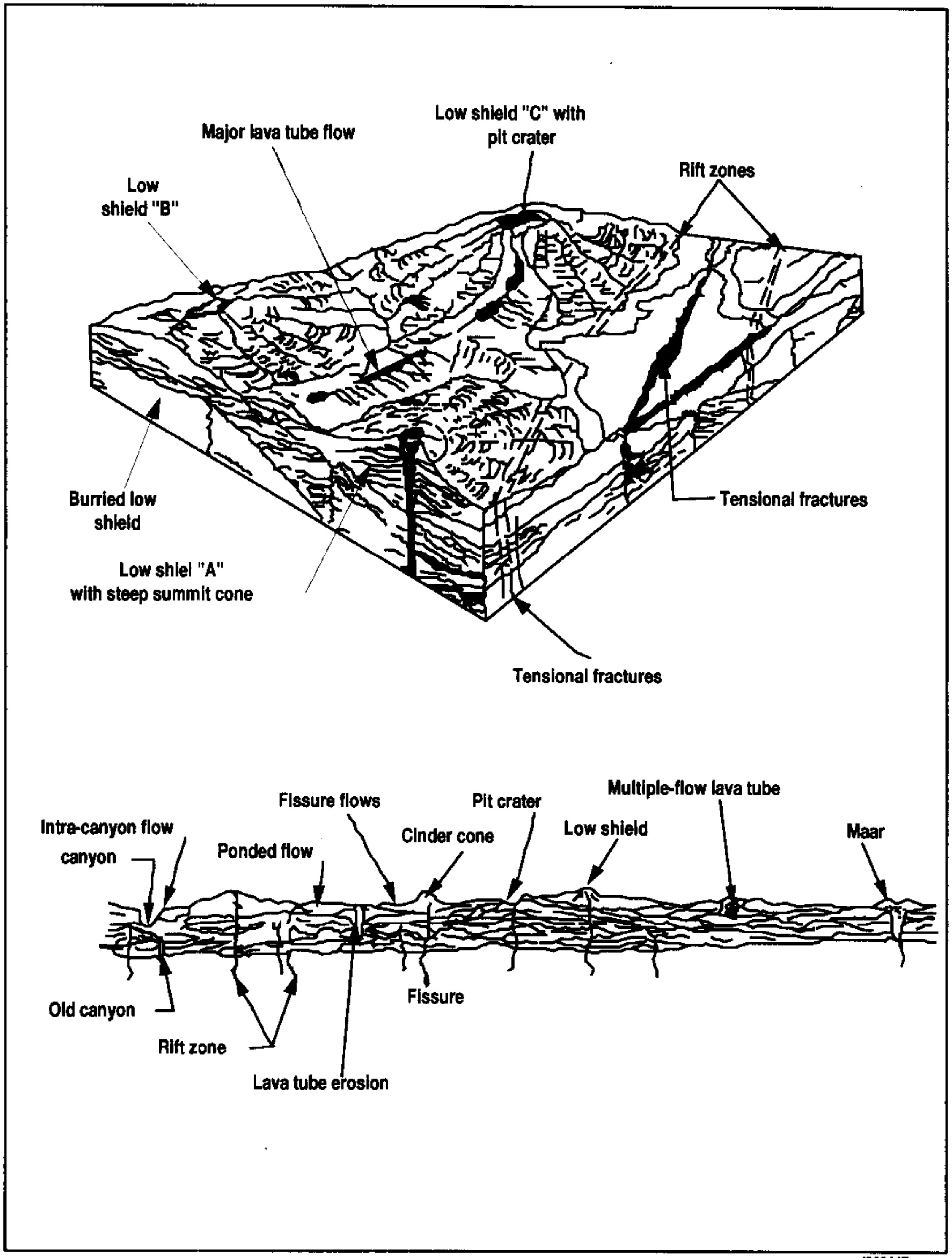


Figure 2-4. Block diagram showing the relationship of low shields, major lava tube flows and fissure flows (J960147).

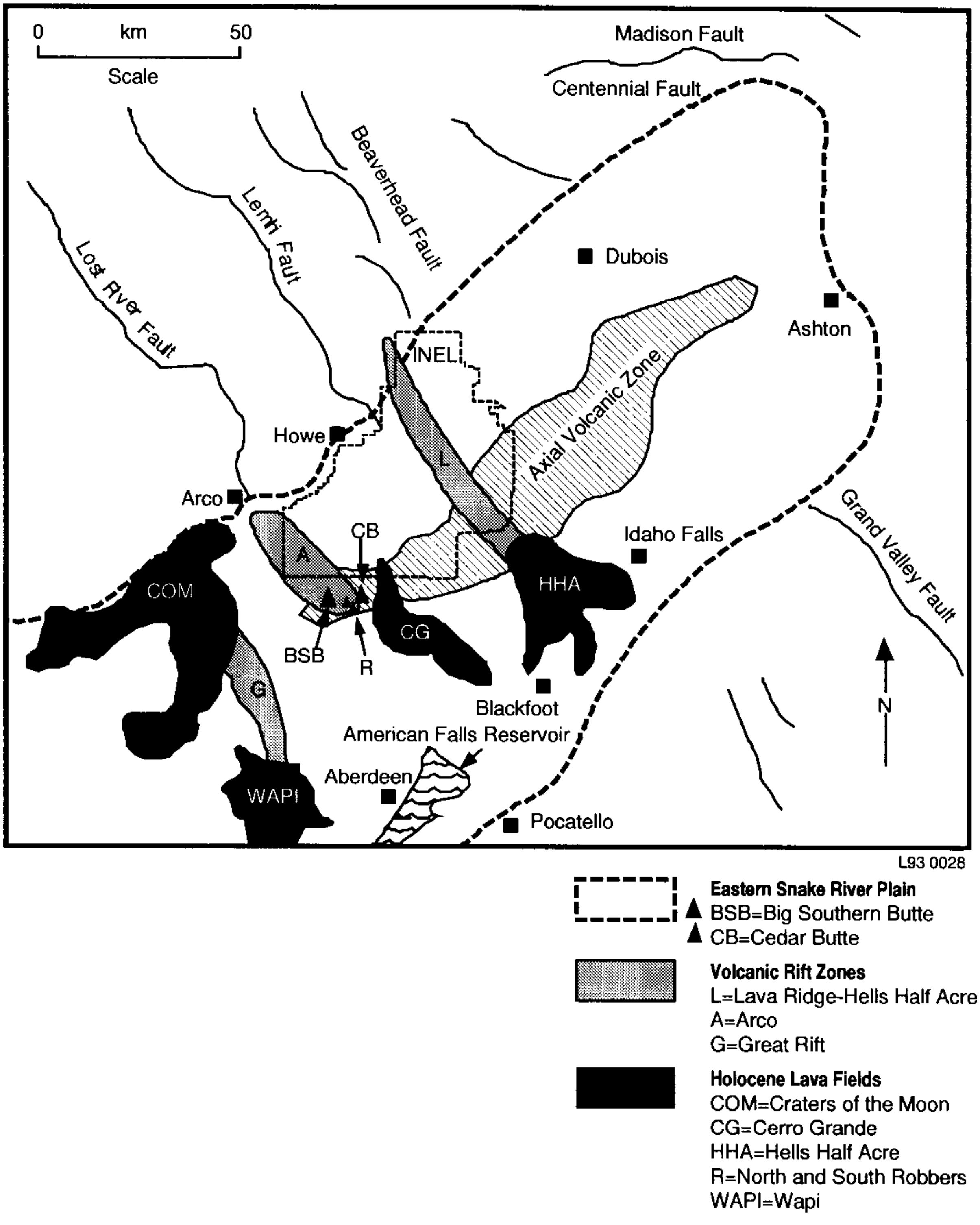


Figure 2-5. Illustration of the axial volcanic zone (L93 0028).

2.3.2 Geology of WAG 4

WAG 4 sits on Big Lost River alluvial deposits (Figure 2-6). The alluvial deposits are underlain by thick sequences of interfingering basalt lava flows and thin sedimentary interbeds, as shown in the geologic cross sections taken from well log data (Figure 2-7). The sequence of basalt flows and interbedded sediments extends well below the water table to a depth of several thousand feet. Basalt lava-flow groups, separated by sedimentary interbeds, are composed of numerous basalt lava flows that erupted from one or more vents. From bottom to top, each lava flow is typically composed of a basal zone of highly permeable rubble; a lower vesicular zone; a dense, massive, and jointed central zone; an upper vesicular zone; and a cap of slabby lava crust. Considerable variation occurs in the characteristics of the basalts. The basalts may be fine or coarse-grained, vesicular or nonvesicular, fractured or jointed. Some fractures and vesicles may be filled with sedimentary material or secondary calcite.

Interbedded sediments consist predominantly of fine-grained silts of eolian origin and clays, silts, sands, and relatively uncommon gravels deposited by streams such as the Big Lost River. Subsurface sedimentary interbeds are lithologically similar to surficial sediments, and past depositional processes and systems are therefore inferred to have been similar to those of recent times. Physical and properties of a shallow sedimentary interbed beneath the CFA Landfills II and III are shown in Table 2-1 (Stephens and Associates 1993). The samples from the interbed tend to be coarse-textured with correspondingly low cation exchange capacity (CEC) and carbon contents. However, physical property variability is evident even in samples collected near each other (e.g., silt and clay contents of samples from wells LF2-12 and LF2-12A). Such variability is also evident over wider distance scales at the INEEL. Grain-size distributions and CECs of sedimentary material from interbeds and basalt fracture fill have been determined at the RWMC a little over 11 km (7 mi) from CFA (Barraclough et al. 1976; Rightmire 1984). Interbed sediments are generally about 60% silt and clay, 35% sand, and 5% gravel. The 34-m (110-ft) interbed at the RWMC is somewhat coarser (10% gravel, 45% sand, 45% silt and clay) than the 73-m (240-ft) interbed (2% gravel, 28% sand, 70% silt and clay). Fracture-fill material in the basalts averaged 22% gravel, 25% sand, and 53% silt and clay.

CEC of the 9-, 34-, and 73-m (30-, 110-, and 240-ft) interbeds at the RWMC averaged 9.0, 7.6, and 15.4 meq/100 g, respectively. The CEC of the fracture-fill sediments was 13.6 and 16.1 meq/100 g for material collected from depths less than 34 m (110 ft) and from the depth interval 34 to 73 m (110 to 240 ft), respectively. Additional variations also occur among the sedimentary interbeds. Some interbeds are continuous beneath the area of the landfills, while others are thin and discontinuous. Some interbeds may also be compacted due to original deposition and subsequent overburden pressures.

Interbeds with relatively high clay content may provide some measure of defense against the possible migration of contaminant leachate from WAG 4 release sites. Such interbeds will impede the downward migration of water and contaminants to the water table by virtue of their very low permeability and high adsorptive capacity. However, many of the interbeds shown in Figure 2-7 and observed in wells at the landfills are thin and discontinuous, confounding subsurface correlations between drill holes. Table 2-2 indicates the depths of interbed clay as observed in the field during drilling of monitoring wells around Landfills II and III. Additionally, there are local pockets or lenses of sand, silt, and clay within the lava flows that were deposited in topographic lows during periods of minimal volcanic activity.

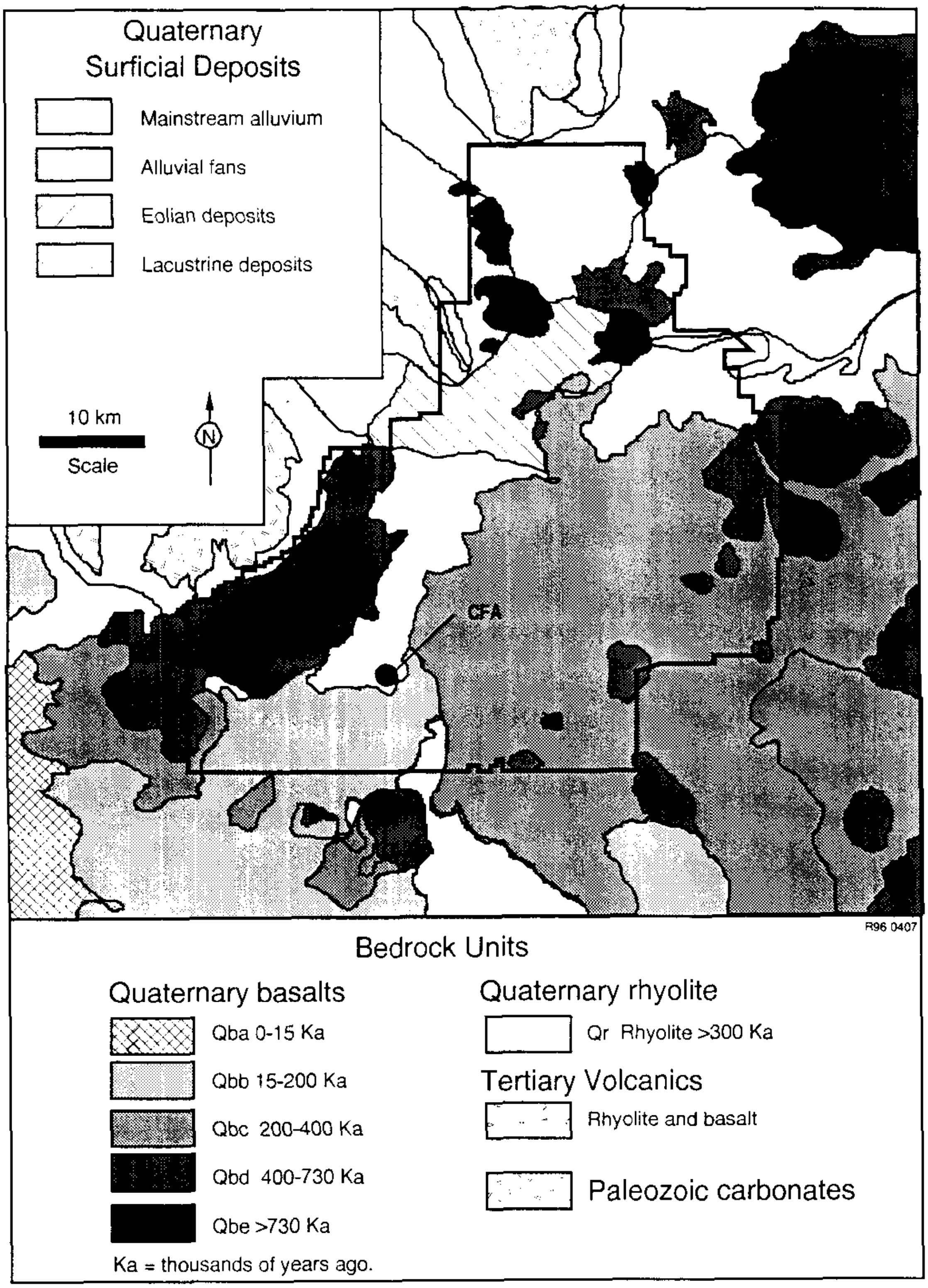
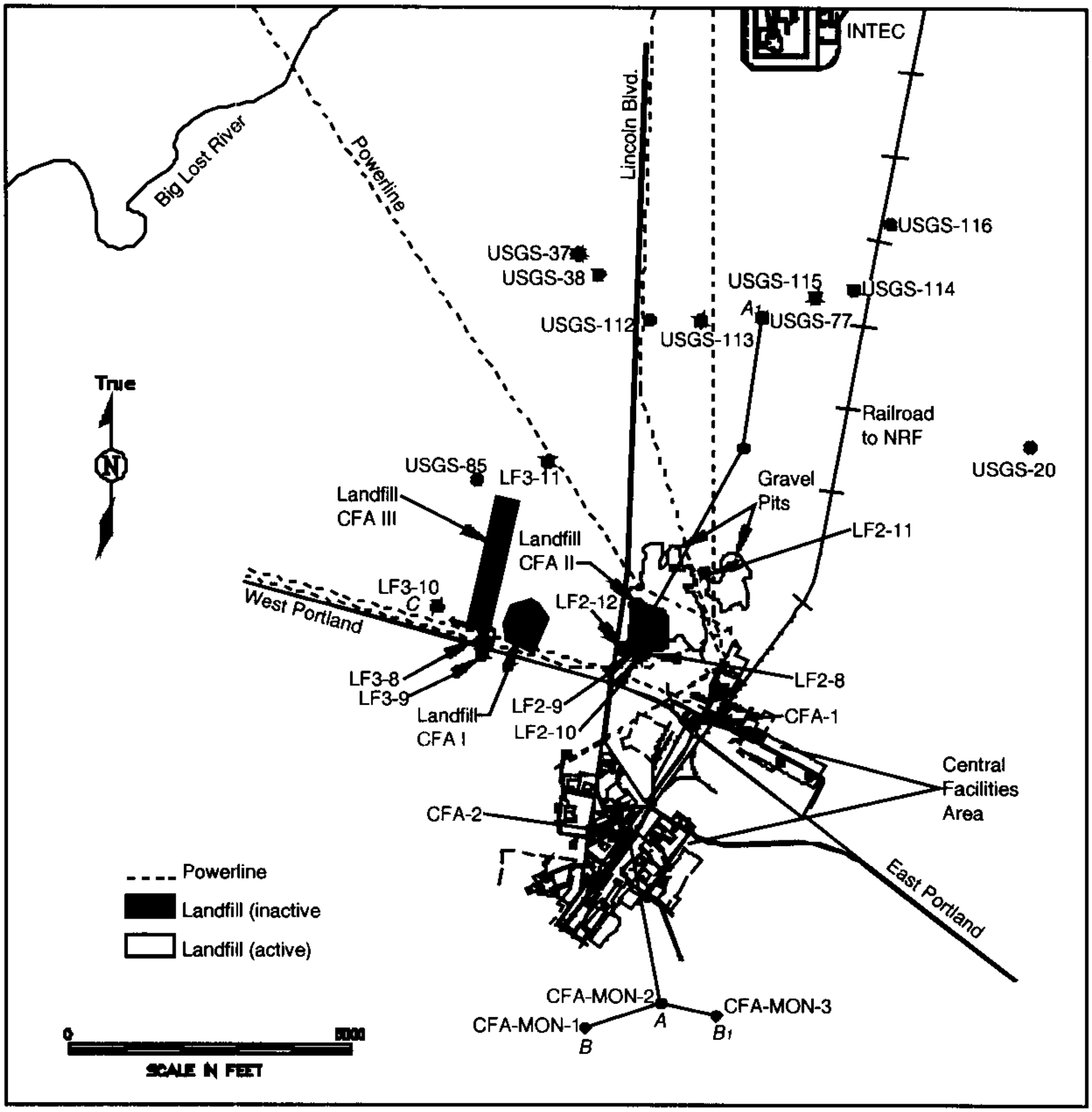


Figure 2-6. Generalized geologic map of the INEEL area, showing CFA in relation to the surficial distribution of major basalt-lava-flow groups and sedimentary deposits (Kuntz et al. 1990, Scott 1982) (R960407).



GA98 1244

Figure 2-7. Stratigraphic cross sections in the vicinity of the CFA landfills.

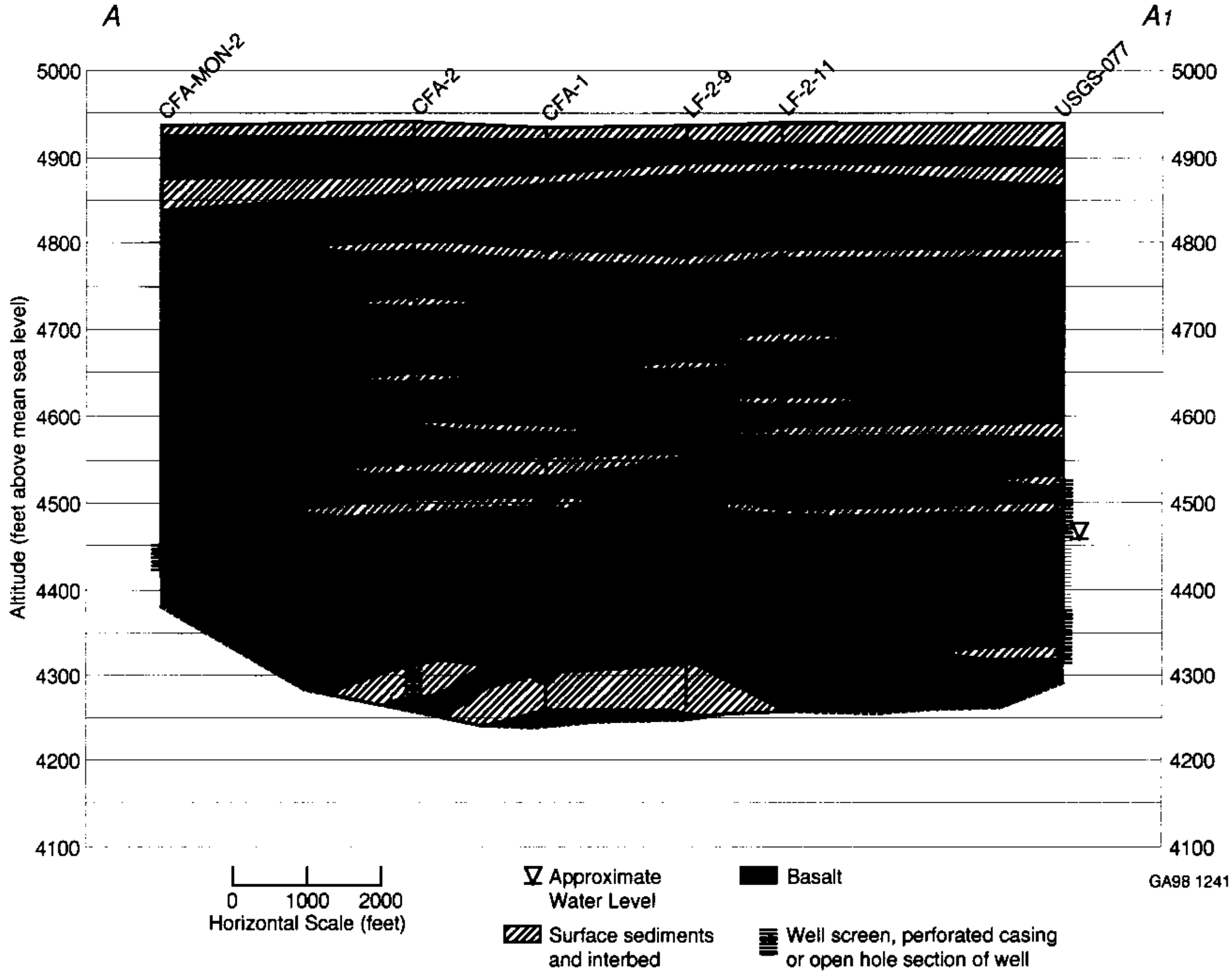


Figure 2-7. (continued).

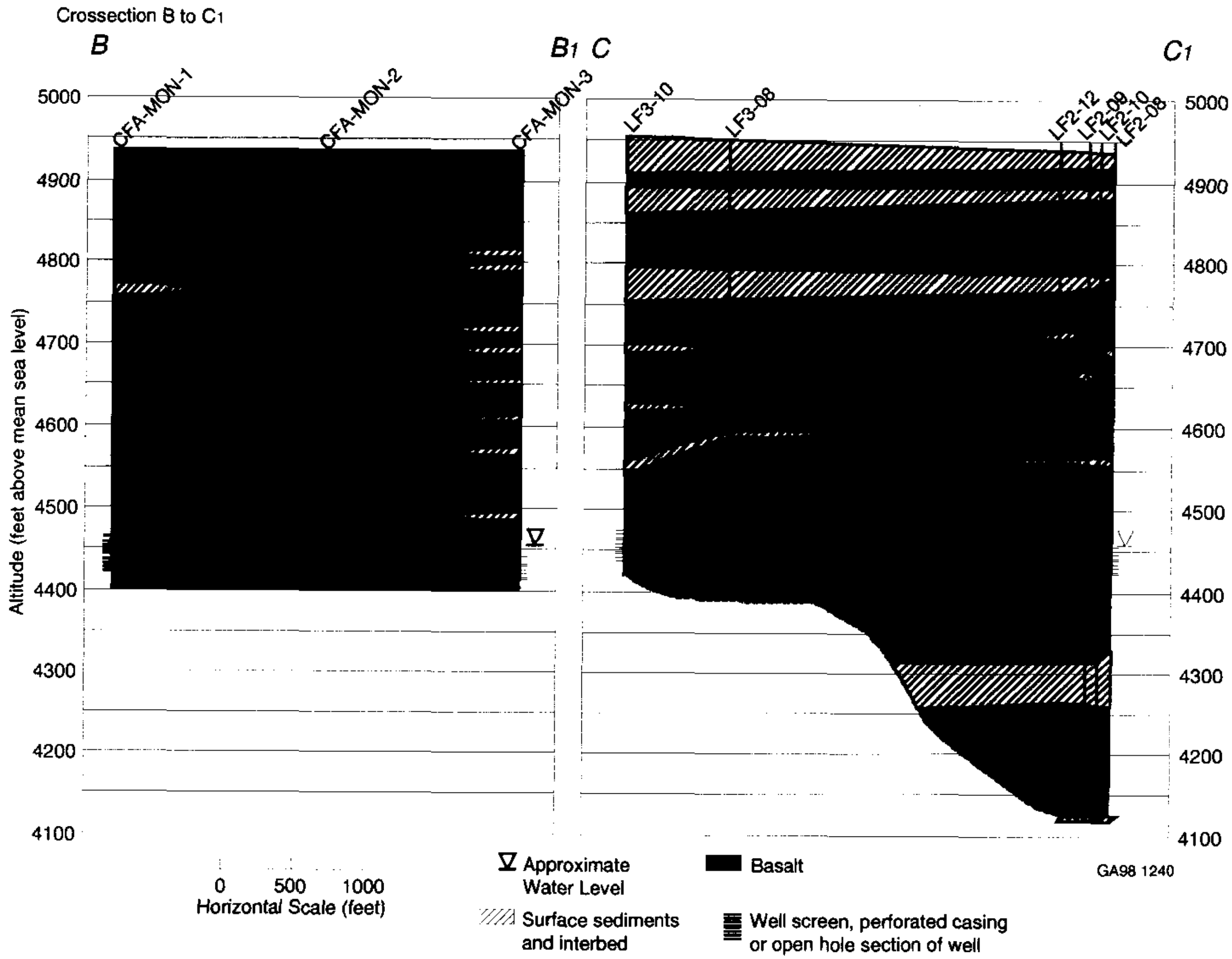


Figure 2-7. (continued).

Table 2-1. Physical properties of a shallow sedimentary interbed at CFA Landfills II and III (Stephens and Associates 1993).

Location	Depth (ft)	Particle Density (g/cm^3)	Bulk Density (g/cm^3)	CEC (meq/100g)	Organic Carbon (%)	Inorganic Carbon (%)	Particle Size: Gravel (%)	Particle Size: Sand (%)	Particle Size: Silt and Clay (%)
LF2-12	48.0–50.3	2.66	1.56	6.8	<0.1	1.0	0.57	97.43	2.00
LF2-12	53.5–55.8	2.7	1.48	4.1	<0.1	0.7	2.56	93.44	17.00
LF2-12	57.1–59.4	2.7	1.77	7.1	0.3	10.3	17.27	65.73	4.00
LF2-12A	46.0–47.5	2.73	1.56	5.3	0.1	3.0	0	100	0
LF2-12A	47.5–48.5	2.79	1.65	6.7	0.1	1.7	76.41	20.59	3.00
LF2-12A	48.5–50.5	2.76	1.71	11.6	<0.1	5.9	1.02	44.98	54.00
LF3-10	60.2–61.0	3.02	1.76	5.3	0.1	6.5	69.05	29.95	1.00
LF3-10	64.4–65.15	2.66	1.76	4.5	0.1	2.9	34.84	63.16	2.00
LF3-10	65.5–67.25	2.67	1.92	5.0	<0.1	3.9	32.92	67.08	0
Average		2.74	1.69	6.27					
Standard Deviation		0.11	0.14	2.26					

Table 2-2. Depths of clay in sedimentary interbeds observed in monitoring wells at CFA Landfills II and III.

Landfill	Monitoring Well	Depth Interval of Clay Layer (ft bgs)[a]	Material[b]
II	LF2-08	185–200	Clay
		372–385	Sandy, clayey silt
	LF2-09	45–65	Sand, clay
		370–385	Silt and clay
		625–645	Silt and clay
	LF2-10	50–65	Clay with trace of silt and sand
		148–149	Clay
	LF2-12	195–197	Clay, sandy
III	LF3-08	150–167	Silt/clay
		185–200	Silt/clay
	LF3-10	55–70	Sand, cinders changing to sand with 25% clay
		90–97	Sand with 20% clay
		150–190	Sand with 0–3% clay
		240–250	Sand with 20–30% clay
	LF3-11	405–415	Sand with silt and clay
	LF3-11	128–135	Clay, wilty with basalt
		190–192	Clay/silt
		352–362	Sand, clay
		410–420	Sand with clay and silt
	USGS-85	55–65	Clay
		95–100	Clay and basalt
		145–165	Basalt and clay
		170–200	Basalt and clay
		298–302	Clay
		345–355	Clay
		515–520	Broken basalt and clay
		612–622	Clay

a. Depths are approximate.

b. The classification of the soil materials is based on a geologist field observations made during drilling.

2.4 Hydrology

This section provides an overview of the hydrology at the INEEL and WAG 4.

2.4.1 Surface Water Hydrology

Surface water on the INEEL consists mainly of three streams draining from intermountain valleys to the north and northwest: the Big Lost River, the Little Lost River, and Birch Creek (Figure 2-8). Water flowing onto the INEEL, either evaporates or infiltrates into the ground because the basin is a closed topographic depression.

Streamflows from the Little Lost River that reach the INEEL have no effect on CFA. The Big Lost River streamflows are also often depleted by irrigation diversions and infiltration losses along the river before reaching the INEEL. Prior to 1993, the Big Lost River had not flowed onto the INEEL since 1986, partly due to the prolonged drought conditions in southeastern Idaho over the previous five years, in addition to the increased upstream irrigation demands. When flow in the Big Lost River actually reaches the INEEL, it is either diverted at a diversion dam (Figure 2-8) or flows northward across the INEEL in a shallow, gravel-filled channel to its terminus at the Lost River sinks where its flow is lost to evaporation and infiltration.

The Big Lost River is approximately 2.4 km (1.5 mi) northwest of CFA at its nearest point. There is no potential impact on the Big Lost River as runoff from CFA infiltrates the desert floor with no discharge to the Big Lost River. Groundwater beneath CFA is approximately 146 m (480 ft) below land surface.

Other sources of surface water on the INEEL consist of precipitation in the form of rain or snow and the subsequent melting of the snow. Precipitation on the INEEL is light and there is little runoff, even locally, except during heavy rainstorms or rapid snow melting (Nace et al. 1956). The evapotranspiration rates are greater than 80% of the available water; therefore, very little water is available to infiltrate the surface soil cover or to provide significant runon/runoff (Anderson et al. 1987).

2.4.2 Regional Groundwater Hydrology

The SRPA, one of the largest and most productive groundwater resources in the United States, underlies the INEEL and is listed as a Class I aquifer. The EPA designated the SRPA as a sole source aquifer under the Safe Drinking Water Act on October 7, 1991. As a result of this determination, Federal financially assisted projects proposed over the SRPA are subject to EPA review to ensure these projects are designed and constructed to protect water quality.

The SRPA consists of a series of saturated basalt flows and interlayered pyroclastic and sedimentary materials that underlie the ESRP. The SRPA is approximately 325 km (200 mi) long, 80 to 112 km (50 to 70 mi) wide, and covers an area of approximately 25,000 km^2 (9,600 mi^2). It extends from Hagerman, Idaho on the west to near Ashton, Idaho, northeast of the INEEL.

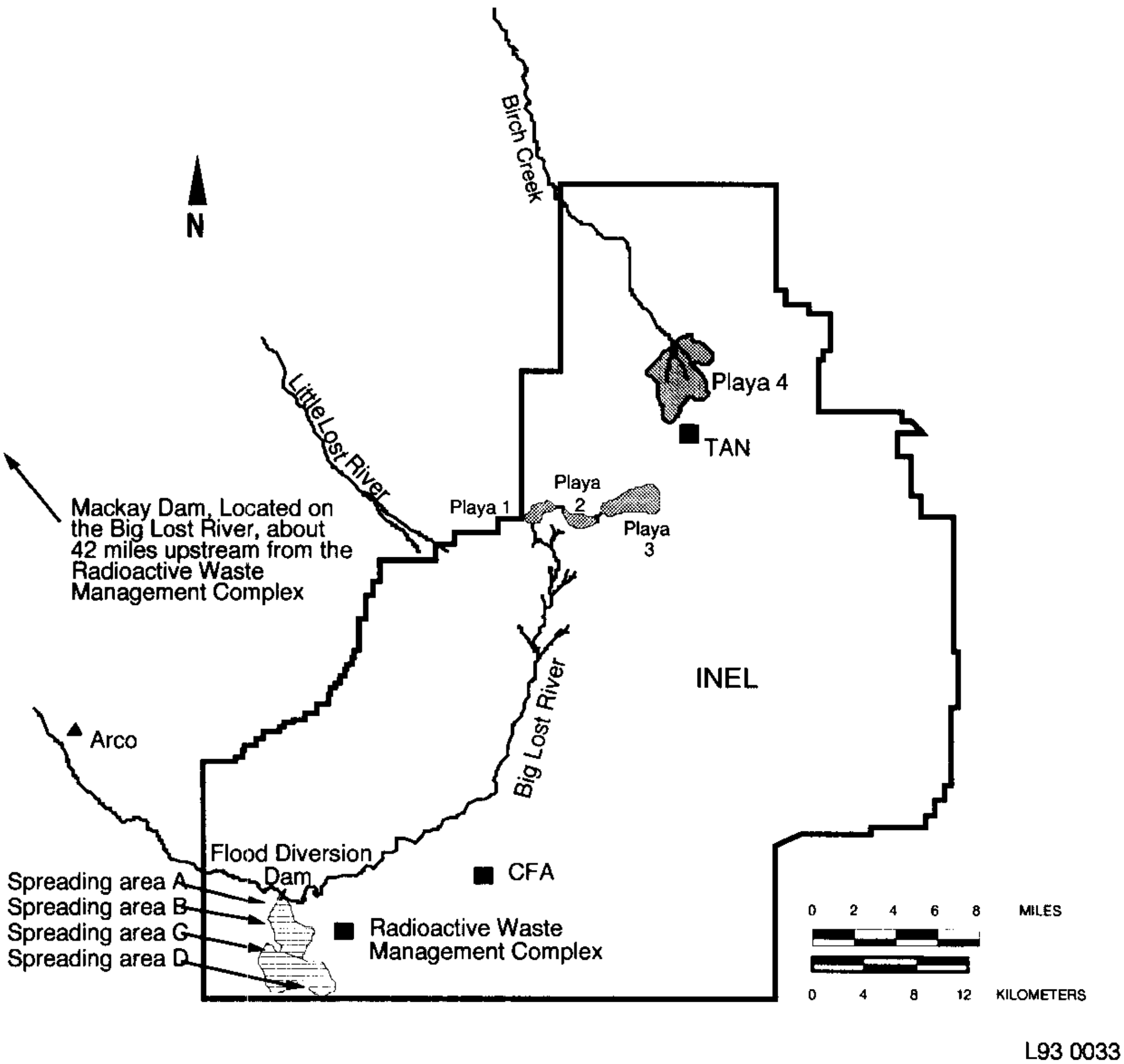


Figure 2-8. Map showing surface water features near or on the INEEL (L93 0033).

Groundwater elevation contours for the SRPA beneath the INEEL are depicted on Figure 2-9. The regional flow beneath the INEEL is south-southwest, although the local direction of groundwater flow may be affected by recharge from streams, surface water spreading areas, and inhomogeneities in the aquifer. Across the southern INEEL, the average gradient of the water table is approximately 0.38 m/km (2 ft/mi) or 0.00038 m/m (0.00038 ft/ft) (Lewis and Goldstein 1982). Depth to water varies from approximately 61 m (200 ft) in the northeast corner of the INEEL to 305 m (1,000 ft) in the southeast corner.

Robertson et al. 1974 estimated that as much as 2.5×10^{12} m^3 (2 billion acre-ft) of water may be stored in the aquifer; approximately 6.2×10^{11} m^3 (500 million acre-ft) are recoverable. Later estimates suggest that the aquifer contains approximately 4.9×10^{11} m^3 (400 million acre-ft) of water in storage. The aquifer discharges approximately 8.8×10^9 m^3 (7.1 million acre-ft) of water annually to springs and rivers. Pumpage from the aquifer for irrigation totals approximately 2.0×10^9 m^3 (1.6 million acre-ft) annually (Hackett et al. 1986).

Recharge to the SRPA from within INEEL boundaries is primarily in the form of infiltration from the rivers and streams draining the areas to the north, northwest, and northeast of the ESRP. In most years, spring snowmelt produces surface runoff that accumulates in depressions in the basalt or in playa lakes. On the INEEL, water not lost to evapotranspiration recharges the aquifer because the INEEL is in a closed topographic depression. Significant recharge from high runoff in the Big Lost River causes a regional rise in the water elevations over much of the INEEL. Water levels in wells in the vicinity of the Big Lost River have been documented to rise as much as 1.8 m (6 ft) following very high river flows (Pittman et al. 1988).

Aquifer tests have been conducted on wells completed in the SRPA to determine the wells' suitability for water supply and to support regional studies conducted by the United States Geological Survey (USGS; Mundorff et al. 1964; Robertson et al. 1974; Wood 1989; Ackerman 1991). Ackerman's transmissivity calculations range from a low of 0.9 m^2/day (10 ft^2/day) in USGS-114 to a high of 68,400 m^2/day (760,000 ft^2/day) in CPP-4, which is a variation of more than four orders of magnitude. The median value is 5,040 m^2/day (56,000 ft^2/day) at USGS-82. This is much lower than the 24,300 to 36,000 m^2/day (270,000 to 400,000 ft^2/day) transmissivity estimated for the regional aquifer at the INEEL. This may be due to the short open interval in the wells rather than a local decrease in transmissivity. None of the wells tested fully penetrate the aquifer; therefore, the transmissivity of the local aquifer in the vicinity of CFA may be somewhat higher. The results of the aquifer tests demonstrate that the aquifer is not homogeneous and isotropic, and that there is considerable variation in the transmissivity and hydraulic conductivity at CFA (Table 2-3).

2.4.3 Groundwater Hydrology at WAG 4

The USGS has maintained a groundwater monitoring network at the INEEL to characterize the occurrence, movement, and quality of water and to delineate the movement of facility-related wastes in the SRPA since 1949. This network consists of a series of wells from which periodic water-level and water-quality data are obtained. Data from the monitoring network are on file at the USGS's INEEL Project Office. Nine groundwater monitoring wells were installed in the northern portion of CFA. The wells were installed to monitor the CFA landfills at both upgradient and downgradient locations. The depth to water in these wells varies from approximately 145 m (476 ft) at LF2-8 to just over 150 m (495 ft) at LF3-8. The hydraulic gradient for the regional aquifer in the vicinity of CFA is approximately 0.2 m/km (1 ft/mi) (Lewis and Jensen 1984). Aquifer storativity was calculated in the vicinity of the CFA landfills using wells LF2-11 and LF3-11 based on barometric efficiency and provided an estimate of 0.0003.

Water in the SRPA shows a chemical composition reflecting the source area of the recharge (Robertson et al. 1974). Recharge from the north and northwest is derived from clastic and carbonate sedimentary rocks and is, therefore, a calcium bicarbonate-type water. Recharge from the east is derived from silicious volcanic rocks and is somewhat higher in sodium, fluoride, and silica. Groundwater at the CFA landfills is of the calcium bicarbonate-type indicative of recharge from the north and northwest.

Documented instances of groundwater degradation at the INEEL have occurred from past waste disposal practices and have had measurable effects on groundwater concentrations in the vicinity of CFA. Radionuclide and chemical constituents detected in the SRPA include tritium, strontium-90, cobalt-60, cesium-137, plutonium-238, plutonium-239, plutonium-240 (undivided), americium-241, total chromium,

Table 2-3. Transmissivity values for wells in the WAG 4 area, based on pumping test evaluations.[a]

Well Name	Completion Zone (ft bgs)	Date of Test	Transmissivity (ft^2/day)
CFA-2	521–651 661–681	2/27/51	170
CPP-1	459.9–485.9 527.4–576.8	8/12/81	73,000
CPP-2	458.3–483.3 551.1–600.25	8/14/81	160,000
CPP-3	412–452 490–593	9/27/51	760,000
USGS-37	507–571.5	7/7/87	16,000
USGS-40	456–678.8	7/28/87	87,000
USGS-43	450.5–675.8	7/29/87	80,000
USGS-51	475–659	6/26/87	2,900
USGS-57	477–732	6/24/87	28,000
USGS-76	457–718	6/10/87	190,000
USGS-82	469–561	6/26/87	56,000
USGS-111	440–600	5/20/87	22
USGS-112	432–563	5/26/87	64,000
USGS-113	445–564	6/1/87	190,000
USGS-114	440–564	5/21/87	10
USGS-115	440–581	5/22/87	32
USGS-116	400–580	5/29/87	150

a. Ackerman (1991).

sodium, chloride, nitrate, and trichloroethene (Orr and Cecil 1991). Tritium and chromium have been detected in the groundwater collected from monitoring wells upgradient and downgradient of CFA. A major source of this groundwater contamination is due to past waste disposal practices at INTEC and TRA, two facilities upgradient of CFA. From 1952 to 1988, approximately 30,900 Ci of tritium contained in waste water from INTEC and TRA operations were disposed to wells and infiltration ponds at these facilities (Mann and Cecil 1990). For example, from 1952 to 1964, an estimated 11,000 kg (24,318 lb) of chromium were contained in wastewater disposed to an unlined infiltration pond at TRA and from 1965 to 1972, an estimated 14,100 kg (31,161 lb) of chromium were contained in wastewater injected directly into the SRPA through a disposal well at TRA (Mann and Knobel 1988).

Dedicated sampling pumps in the landfill monitoring wells, which were manufactured in part with high-chromium stainless steel, introduced particulate chromium into samples collected from these wells during previous groundwater sampling events in 1989 and 1990. The dedicated sampling pumps were removed from the monitoring wells prior to sampling these wells in the 1993 OU 4-12 RI. Data collected from these wells indicate that chromium concentrations are below the maximum contaminant level (MCL) of 100 µg/L with an average concentration of 11 µg/L. Data collected from these wells indicates that there is no significant difference in concentration between upgradient and downgradient wells.

The sources of drinking water for site employees at CFA consist of two production wells (CFA-1 and CFA-2). A drinking water program was initiated in 1988 to monitor drinking water wells on the INEEL for compliance with community water system standards as established by EPA and State of Idaho regulations, as well as applicable DOE orders. Samples collected from CFA-1 and –2 production wells are analyzed for radionuclides (gross alpha, beta, and tritium), organics, inorganics (nitrates), and metals.

2.4.4 Perched Water at CFA

Two perched water zones existed beneath the sewage treatment plant drainfield (OU 4-08) from 1944 through 1995. These zones were the result of waste water discharged to the sewage treatment plant drainfield during this period. The average flow rates vary from 662,375 L (175,000 gal) to 757,000 L (200,000 gal/day) during the summer and 416,350 L (110,000 gal)/day during the winter. The sewage treatment plant and drainfield were deactivated in 1995. The lower perched water zone has since dissipated as evidenced in June 1996 when no water was found in the well. The upper perched water has also dissipated as evidenced in January 1997, when no water was found in the well.

2.5 Ecology

A thorough discussion of the ecology of WAG 4 is contained in Section 7 of this report, "WAG 4 Ecological Risk Assessment."

2.6 Demography and Land Use

2.6.1 Demography

The INEEL consists of 2,305 km^2 (890 mi^2) of Federally owned land that has been withdrawn from public use by DOE. The INEEL is a controlled access area where only employees and approved contractor personnel are allowed. Public access to the INEEL is limited to two Federal highways and three state highways. Other roads within the INEEL boundary are restricted to personnel and visitors on official business. There are approximately 5,000 employees on the INEEL during the day; approximately 820 of those are at CFA. The mission of CFA is to provide efficient, centralized support services for programmatic and nonprogrammatic efforts of all INEEL contractors and DOE. The support services provided include warehousing, craft shops, research laboratories, administrative offices, and landfills.

The INEEL is contained within five counties: Bingham (39,613 population), Bonneville (77,395), Butte (2,940), Clark (798), and Jefferson (17,486) (Figure 2-10). Major communities include Blackfoot and Shelley in Bingham County, Ammon and Idaho Falls in Bonneville County, Arco in Butte County, and Rigby in Jefferson County. The nearest community to the INEEL is Atomic City, located south of the INEEL border on Highway 26. Other population centers near the INEEL include Howe, west of the Site on U.S. Highway 22/33; and Mud Lake and Terreton on the INEEL's northeast border, 17.6 km (11 mi) east of TAN.

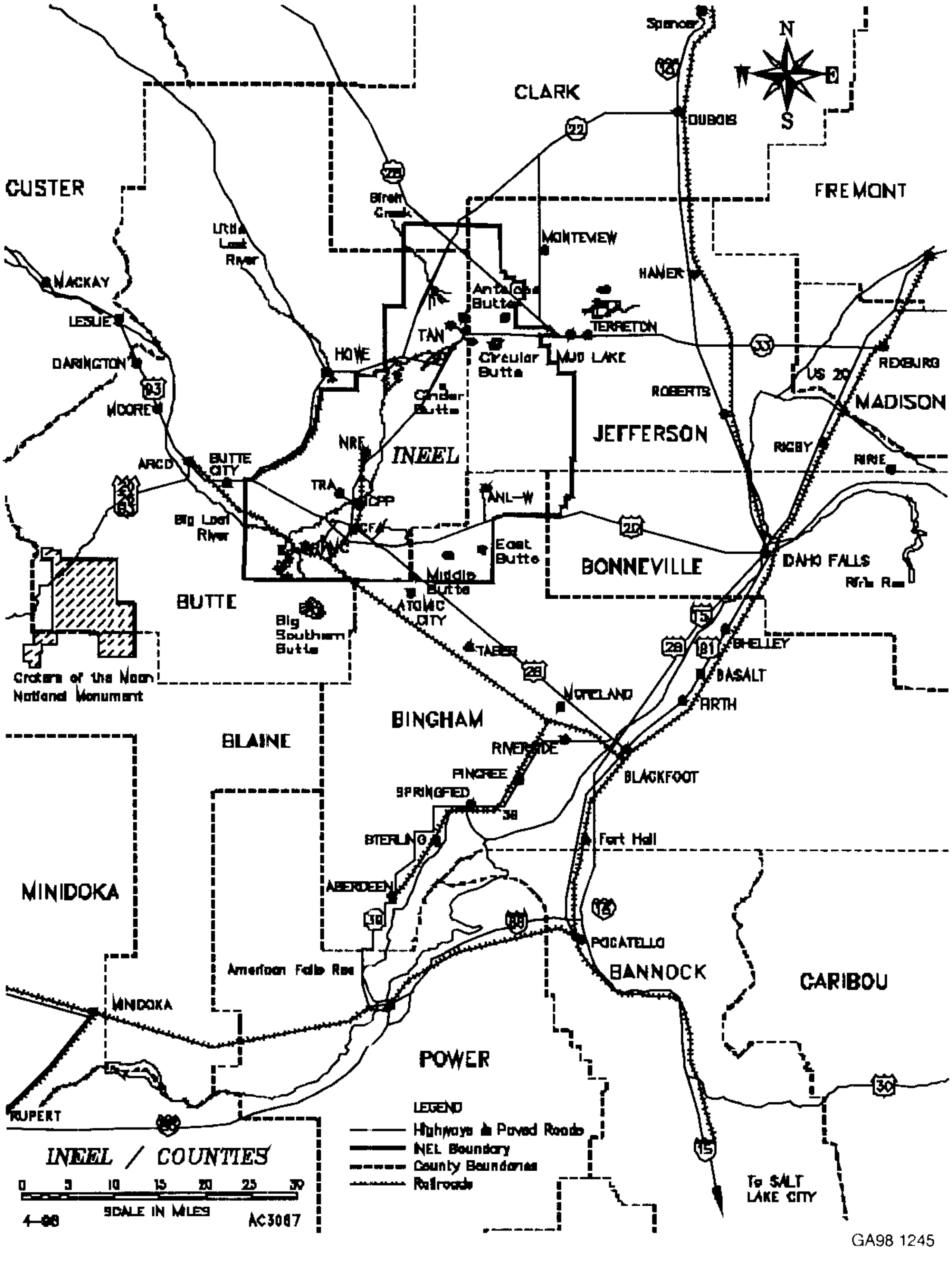


Figure 2-10. Counties adjacent to the INEEL and public transportation routes in the area (AC3087).

2.6.2 Land Use

2.6.2.1 Current. The BLM has classified the acreage within the INEEL as industrial and mixed use (DOE 1996). It is used as a nuclear research, materials, and development facility. The INEEL was designated as a National Environmental Research Park in 1975. As such, it is used as a controlled outdoor laboratory, where scientists can study changes in the natural environment caused by human activities.

The developed area within the INEEL is surrounded by a 1,295 km^2 (500 mi^2) buffer zone of grazing land for cattle and sheep (DOE 1996). Grazing areas at the INEEL, shown in Figure 2-11, are administered by the BLM. Because of dry conditions, cattle have been grazed on-Site in the past few years. During selected years, depredation hunts of game animals, managed by the Idaho Department of Fish and Game, are permitted on-Site. Hunters are allowed in a hunting zone that extends 0.8 km (0.5 mi) inside the INEEL boundary on portions of the northeast and west borders of the Site.

State Highways 22, 28, and 33 cross the northeastern portion of the Site, and U.S. Highways 20 and 26 cross the southern portion (Figure 2-11). State Highway 33 crosses the TAN area immediately southeast of TSF. There are a total of 145 km (90 mi) of paved highways used by the general public that pass through the INEEL (DOE 1996). Fourteen miles of the Union Pacific Railroad traverse the southern portion of the Site. A government-owned railroad passes from the Union Pacific Railroad line through CFA to the Naval Reactor Facility. A spur runs from the Union Pacific Railroad line to the RWMC. Land ownership distribution in the vicinity of the INEEL and on-site areas are open for grazing under a permit system. In the counties surrounding the INEEL, approximately 45% of the land is used for agriculture, 45% is open land, and 10% is urban. Agricultural uses include production of sheep, cattle, hogs, poultry, and dairy cattle (Bowman et al. 1984). Crops grown include potatoes, sugar beets, wheat, barley, oats, forage, and seed crops. Most of the land surrounding the INEEL is owned by private individuals or the U.S. Government (administered by the BLM) (Figure 2-11).

2.6.2.2 Future. Future land use at the INEEL will most likely remain industrial. CFA facilities are planned to continue with new industrial development through the 100 year time-frame and will be used as the central support facility for the INEEL (DOE 1996). Future uses of the land utilized by the INEEL may include agriculture, residential, or return of the land to an undeveloped state. The human health risk assessment, presented in Section 6 of this document, evaluates potential risks from site contaminants using the residential exposure scenario which starts at the end of the 100-year time-frame. This scenario is the most conservative of other possible scenarios (i.e., industrial).

To evaluate potential occupational risks from exposure to soil, it is assumed that both current and future workers at the sites will only be exposed to contamination from the top 15 cm (6 in) of soil for the soil ingestion, inhalation of fugitive dust and VOC exposure routes. For the evaluation of external radiation exposure, radionuclide activities present in the top 1.2 m (4 ft) of soil will be used. This analysis method is referred to as the occupational nonintrusion exposure scenario, and all occupational exposure scenario analyses in the OU4-13 BRA will include an evaluation of this exposure scenario.

For the purposes of the BRA, it is assumed that future residents will construct 3 m (10 ft) basements beneath their homes. As a result, all contamination detected in the upper 3 m (10 ft) of each release site will be evaluated for surface pathway exposures. This analysis method will hereafter be referred to as a "residential intrusion scenario," and all residential exposure scenario analysis in the OU 4-13 BRA will include the residential intrusion assumption.

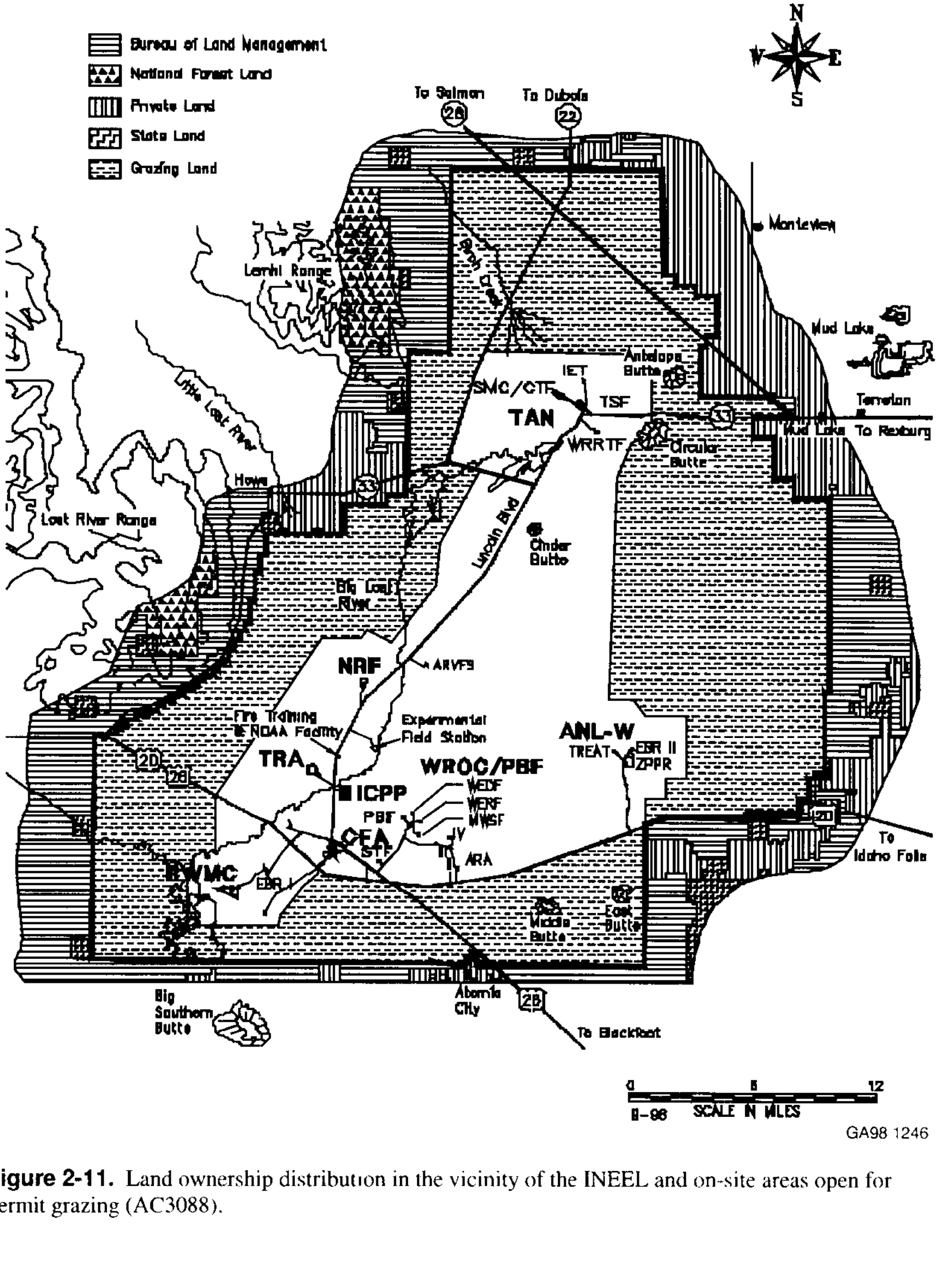


Figure 2-11. Land ownership distribution in the vicinity of the INEEL and on-site areas open for permit grazing (AC3088).

2.7 References

Ackerman, D. J., 1991,"Transmissivity of the Snake River Plain Aquifer at the Idaho National Engineering Laboratory, Idaho," *U.S. Geological Survey Water-Resources Investigations Report* 91-4058.

Anderson, et al., 1987, "Control of the Soil Water Balance by Sagebrush and Three Perennial Grasses in a Cold-Desert Environment," *Arid Soil Research and Rehabilitation, 1*, pp. 229–244.

Armstong, R. L., W. P. Leeman, and H. E. Malde, 1975, "K-Ar Dating, Quaternary and Neogene Rocks of the Snake River Plain, Idaho," *American Journal of Science*, pp. 225–251.

Barraclough, J. R., J. B. Robertson, and V. J. Janzer, 1976, "Hydrology of the Solid Waste Burial Ground, as Related to the Potential Migration of Radionuclides," *U.S. Geological Survey Open-File Repot 76-471*.

Barthlomay R. C., 1990, *Mineralogical Correlation of Surficial Sediment from Area Drainages, with Selected Sedimentary Interbeds at the Idaho National Engineering Laboratory, Idaho*, U.S. Geological Survey Water Resources Investigations Report 90-4147, August.

Bowman, A. L., W. F. Downs, K. S. Moor, and B. F. Russell, 1984, *INEL Environmental Characterization Report*, Vol. 2, EGG-NPR-6688, September.

Clawson, K. L., G. E. Start, and N. R. Ricks, 1989, *Climatography of the Idaho National Engineering Laboratory*, 2nd edition., DOE/ID-12118, December.

Hackett, B., J. Pelton and C. Brockway, 1986, "Geohydrologic Story of the Eastern Snake River Plain and the Idaho National Engineering Laboratory," DOE/ID, November.

Hull, L. C. 1989, *Conceptual Model and Description of the Affected Environment for the TRA Warm Waste Pond (Waste Management Unit TRA-03)*, EGG-ER-8644, October.

Kaminsky, J. F. et al., 1993, *Remedial Investigation Final Report with Addenda for the Test Area North Groundwater Operable Unit 1-07B at the Idaho National Engineering Laboratory*, EGG-ER-10643, Rev. 0, August.

Kuntz, M. A., 1992, "A Model-Based Perspective of Basaltic Volcanism on the ESRP, Idaho," In: *Regional Geology of Eastern Idaho and Western Wyoming*, Geological Society of America Memoir 179.

Leeman, W. P., 1982, "Olivine Tholeiitic Basalts of the Snake River Plain, Idaho," *Cenozoic Geology of Idaho*, Idaho Geological Survey Bulletin 26, pp. 181B191.

Lewis, B. D. and F. J. Goldstein, 1982, *Evaluation of a Predictive Ground-Water Solute-Transport Model at the Idaho National Engineering Laboratory*, IDO-22062, U.S. Geological Survey Water-Resources Investigation 82-25.

Lewis, B. D. and R. G. Jensen, 1984, *Hydrologic Conditions at the Idaho National Engineering Laboratory, Idaho, 1979–1981 Update*, U.S. Geological Survey Open-File Report 84-230, IDO-2066.

Mabey, D. R., 1982, *Geophysics and Tectonics of the Snake River Plain, Idaho,* Idaho Geological Survey Bulletin 26, pp. 139B154.

Mann, L. J. and L. D. Cecil, 1990, "Tritium in Ground Water at the Idaho National Engineering Laboratory, Idaho ," *U.S. Geological Survey Water Resources Investigations Report 90-40901*, DOE/ID-22075, Idaho Falls, ID.

Mann, L. J and L. L. Knobel, 1988, "Concentrations of Nine Trace Metals in Ground Water at the Idaho National Engineering Laboratory, Idaho," *U.S. Geological Survey Open-File Report 88-332*, DOE/ID-22075, Idaho Falls, ID.

Mundorff, M. J., E. G. Crosthwaite, and C. Kilburn, 1964, *Ground Water for Irrigation in the Snake River Basin in Idaho*, U.S. Geological Survey, Water Supply Paper 1654.

Nace, R. L., M. Deutsch, and P. T. Voegeli, 1956, *Geography, Geology, and Water Resources of the National Reactor Testing Station, Idaho: Part 2, Geography, and Geology*, IDO-22033, U.S. Geological Survey, Boise, ID.

Nace, R. L., P. T. Voegeli, J. R. Jones, and M. Deutsch, 1975, *Generalized Geologic Framework of the National Reactor Testing Station, Idaho,* Geological Survey professional paper.

Orr, B. R. and L. D. Cecil, 1991, "Hydrologic Conditions and Distribution of Selected Chemical Constituents in Water, Snake River Plain Aquifer, Idaho National Engineering Laboratory, Idaho 1986 to 1988," *U.S. Geological Survey-Water Resources Investigations Report 91-4047*, DOE/ID-22096.

Pierce, K. L., and L. A. Morgan, 1992, "Track of the Yellowstone Hotspot: Volcanism, Faulting, and Uplift," *Geological Society of America Memoir 179*, pp. 1B53.

Rightmire, C. T., 1984, "Description and Hydrologic Implications of Cored Sedimentary Material from the 1975 Drilling Program at the Radioactive Waste Management Complex, Idaho," *U.S. Geological Survey Open-File Report 84-4071*.

Robertson, J. B., R. Schoen, and J. T. Barrraclough, 1974, *The Influence of Liquid Waste Disposal on the Geochemistry of Water at the National Reactor Testing Station, Idaho: 1952–1970*, U.S. Geological Survey Open-File Report, IDO-22053, Waste Disposal and Processing TID-4500.

Sagendorf, J., 1991 *Meteorological Information for RWMC Flood Potential Studies*, U.S. Department of Commerce, National Oceanic and Atmospheric Administration, Environmental Research Laboratories, Air Resources Laboratory Field Research Division, Idaho Falls, Idaho.

Scott, W. E. 1982, "Surficial Geologic Map of the Eastern Snake River Plain and Adjacent Areas, Idaho and Wyoming, "U.S. Geological Survey Miscellaneous Investigation Map I-1372.

Van Deusen, L., and R. Trout, 1990, *Draft, Phase I Remedial Investigation/Feasibility Study Work Plan and Addendum for the Warm Waste Pond Operable Unit at the Test Reactor Area of the Idaho National Engineering Laboratory (Volumes I and II),* EGG-WM-8814, July.

Whitehead, R. L., 1986, "Geohydrologic Framework of the Snake River Plain, Idaho and Western Oregon," U.S. Geological Survey Atlas, HA-681.

Wood, T. R., 1989, *Test Area North Pumping Tests*, EGG-ER-8438, January

3. OU 4-13 REMEDIAL INVESTIGATION AND WAG 4 REMOVAL ACTIONS

This section presents the precision, accuracy, representativeness, and completeness of data used on the BRA. These parameters were evaluated for data collected from the OU 4-13 field investigation at sites CFA-04 and CFA-08 and at the 1997 Miscellaneous Sites Non-time Critical Removal Action. Additional background information on specific sites may be found in Section 4 of this report.

3.1 CFA-04 Pond

The objectives of the field investigation at the CFA-04 Pond were to determine:

1. The mean and maximum concentrations of the COPCs,

2. The extent of contamination,

3. If leaks from the pipe from building CFA-674 to the pond occurred and were a source of contamination,

4. If subsurface geophysical anomalies were sources of contamination, and

5. The topographical features of the pond for use in evaluating remedial activities.

The first objective was met by collecting enough samples in and around the pond to ensure that a comparison could be made with background concentrations (see Figure 3-1). Samples were collected in accordance with the Field Sampling Plan (FSP) (Blackmore 1997a). The number of samples for each analyses was determined in the OU 4-13 SAP (Blackmore 1997a) by applying statistical tests to data from previous investigations. These tests were performed to ensure that enough samples were collected to determine the mean and maximum concentrations. The number of samples for each contaminant were calculated as follows: mercury—29, arsenic—3, U-235—13, and U-238—13.

The second, third, and fourth objectives were met by collecting samples from: random locations in the pond area, locations near the pipeline, locations in the windblown areas, and locations in the geophysical anomalies. The random pond area locations were collected based on the statistical analysis of data collected prior to this RI. The pipeline locations were collected to determine if the pipeline had leaked and caused contamination of the surrounding soil. The windblown samples were collected to determine whether or not calcine in the pond had been transported by wind to surface soils surrounding the pond. Samples from the geophysical anomalies were collected to determine if contaminants were released to the anomaly areas.

The fifth objective was met with the completion of a topographic survey of the pond and surrounding area. The purpose of the survey was to produce a topographic map that would support future remedial plans for the pond.

Mercury Retort Area Sampling—1997. Additional data were collected in November 1997 in the staging area, which was used for retort equipment and tanks, and waste storage (Figure 3-2). The objective of this sampling activity was to determine whether soil contamination occurred as a result of equipment operation and water storage. This objective was met with the collection of 48 samples from

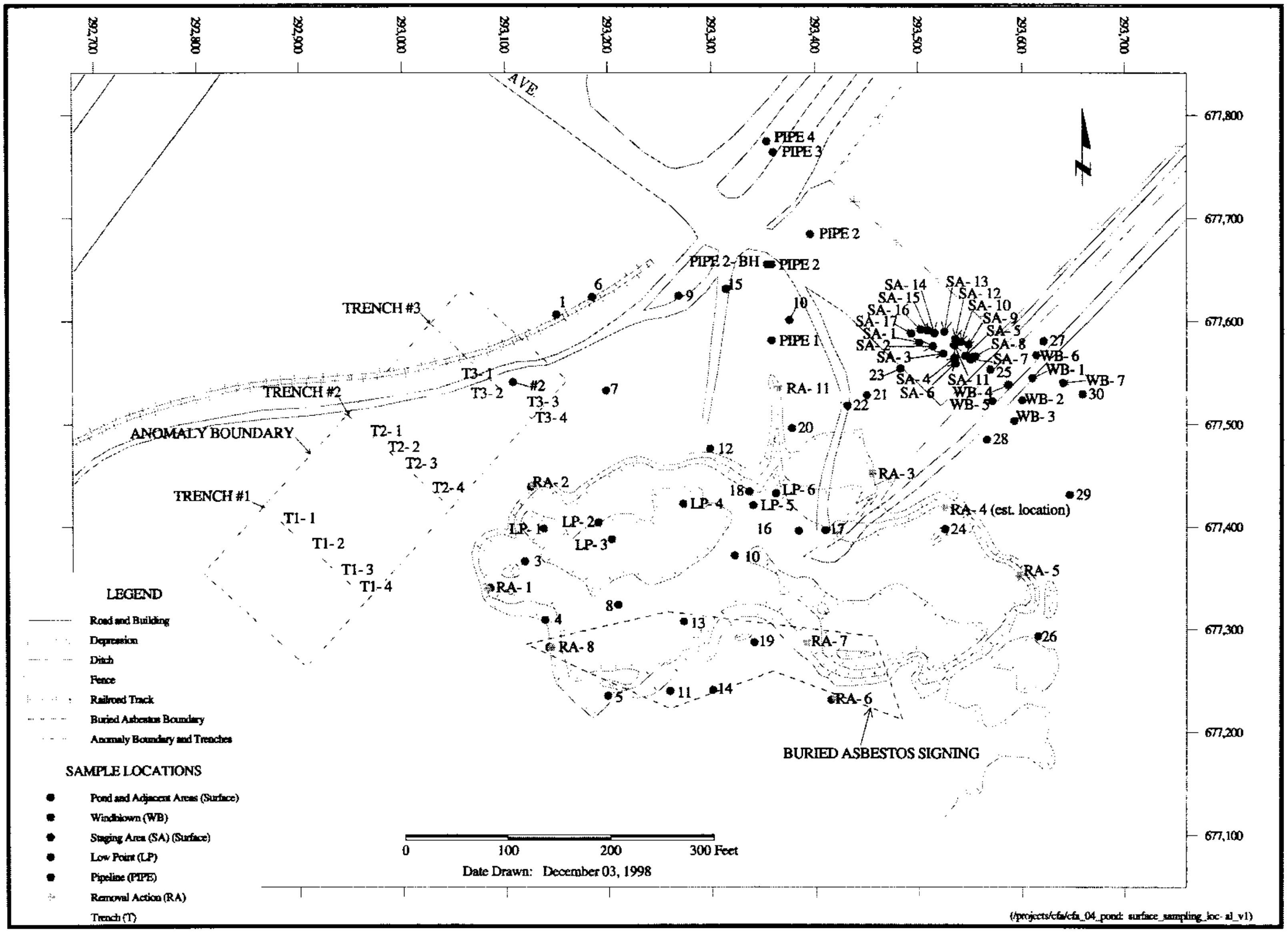


Figure 3-1. Sample locations at CFA-04 Pond (1995–1997).

45 locations (3 duplicates) in the staging area. The samples were analyzed for metals (including mercury), gamma-emitting and uranium radionuclides, nitrate/nitrite, and TCLP metals. No critical samples were designated.

OU 4-13 RI/FS Sampling—1998. Additional data were collected during July 1998 to refine the type and volume of contaminated soil in the pond (Figure 3-2). The specific objectives were to:

1. Determine the hazardous waste status of previous sampling locations in the pond bottom where mercury was detected. This included determining whether "hot spot" or "cold spot" locations pass of fail TCLP analysis.

2. Determine the extent of mercury contamination above the PRG to a depth of 1m (3 ft) below the bottom of the pond.

3. Determine the rad added status of the pond sediments using TPR-713 analysis.

These objectives were met with the collection of 96 samples (including 4 duplicates) from different depths at 40 locations. No critical samples were identified for this sampling activity.

3.2 CFA-08 Drainfield

The objectives of sampling at the CFA-08 Drainfield were to determine:

1. The mean and maximum activity of Cs-137 in the surface and subsurface soils of the drainfield

2. The vertical and lateral extent of subsurface contamination at the alluvium-basalt interface adjacent to the drainfield

3. The topographical features of the drainfield for use in evaluating remedial alternatives

4. The extent of potential contamination from the delivery pipelines and the nature of waste in the pipelines.

5. The presence or absence of potential contamination beneath the STP structures.

The first objective was met by collecting enough surface and subsurface soil samples from locations randomly located in the drainfield. Samples were collected in accordance with the FSP (Blackmore 1997a). The number of samples for each specific analysis was determined in the OU 4-13 SAP (Blackmore 1997a) by applying statistical tests to data from previous investigations. These tests were performed to ensure that enough samples were collected to determine the mean and maximum concentrations. The tests resulted in the following number of samples for each contaminant: arsenic–3, Cs-137-6, and U-235/8–13. Samples were analyzed for uranium isotopes because these were known contaminants.

The second objective was met by collecting soil samples from twenty boreholes located just outside boundary of drainfield (see Figure 3-3). Biased borehole samples were collected at depths ranging from 0 to 4, 4 to 8, 12 to 16, and at the soil-basalt interface at approximately 18 to 27 ft. This

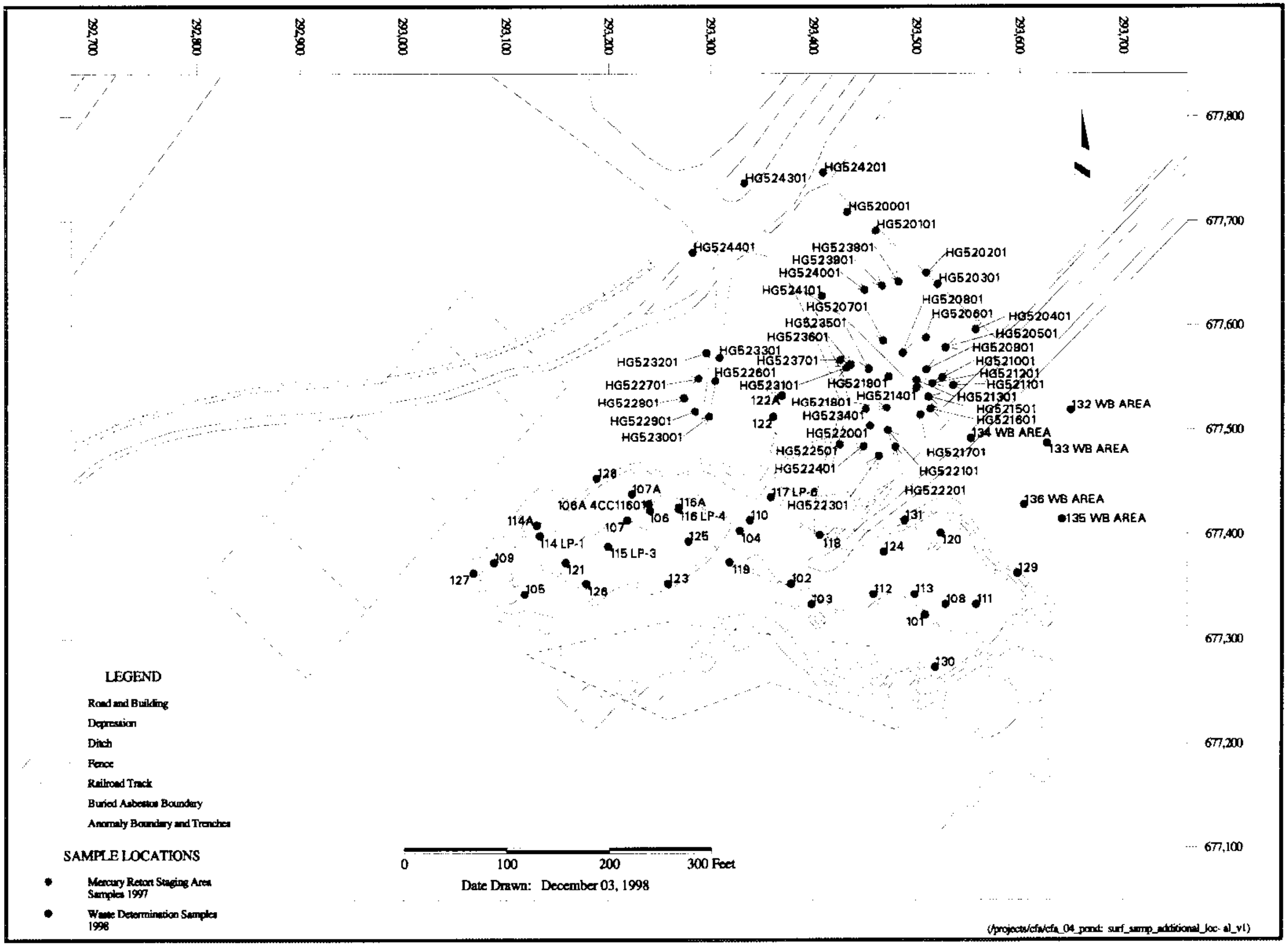


Figure 3-2. Sample locations at CFA-04 pond (1997 and 1998).

involved using positive detections of Sr-90 as an indicator of lateral migration of contaminants from the drainfield. An estimate of lateral migration of radionuclides toward the aquifer was made in the RI/FS Work Plan (McCormick 1995) as part of a source term evaluation using data from the Track 2 investigation. The Track 2 risk assessment indicated that the primary sources of potential risks are radionuclides, especially Cs-137, in the surface soils of the drainfield. The Track 2 data also indicated that Cs-137 and other radionuclides are predominately in the surface soils. The other COPCs (both rads and non-rads) for which samples were collected in the drainfield showed only sporadic detections at depth with the exception of Sr-90. While Sr-90 is not the most mobile of the COPCs found in the drainfield, it did show much higher and more consistent detections at depth than the other COPCs. The objective of the RI/FS drainfield boreholes was to determine the lateral extent of contamination around outside of the drainfield. The Track 2 data indicated that no significant contamination existed directly beneath the drainfield, the COPC with the most mobility in the perched water zone was chosen as an indicator of whether or not contamination had moved laterally along the soil-basalt interface.

Samples were analyzed for Sr-90 at the Radiation Measurements Laboratory (RML) at the INEEL. Analyses for other COPCs from a particular borehole location were performed only if Sr-90 was positively detected. As a result of this process additional samples were collected at only one of twenty drainfield boreholes.

The third objective was met by performing a topographic survey of the drainfield and surrounding area. All sample locations were surveyed and plotted on a topographic map.

The fourth objective was met by collection of samples from the pipeline sludge and from the soils surrounding the pipelines.

The fifth objective was met with collection of samples beneath the STP. The D&D program investigated potential releases from the components of the sewage treatment plan in 1996 (Stormberg 1996). The objective of the investigation was to characterize potential releases from the plant at the soil-basalt interface. Subsurface soil samples were collected from boreholes and analyzed for metals, radionuclides, and SVOCs (see Figure 3-4). The borehole locations were biased toward areas with the greatest potential for leakage from the plant. The boreholes were located next to the concrete structures that held large volumes of water and close to underground piping where leakage might be expected. The twelve borehole locations were completed and all samples were collected and analyzed. Additional data were collected in 1998 from beneath the structures to determine the hazardous waste status for metals. In addition, field instrument surveys to detect possible releases of radiological contaminants were conducted on the soils after removal of structures and piping.

Analytical data from 1996 and 1998 indicate the presence of U-235 and Ra-226 in samples from the boreholes beneath the plant. All other potential contaminants (VOCs, SVOCs, PCBs, radionuclides, and metals) were not detected or detected below background and/or risk-based concentrations (see Appendix C for screening). Analysis of samples for TCLP in the completeness results for these data are included in Table 3-2.

3.3 CFA-10 Transformer Yard Oil Spills

Data were collected at the CFA-10 Transformer Yard Oil Spills site during July 1998 (Figure 3-5). The objectives of this sampling activity were to:

1. Determine the presence, or absence, of lead contamination above 400-mg/kg at depths of 0.61 m (2 ft).

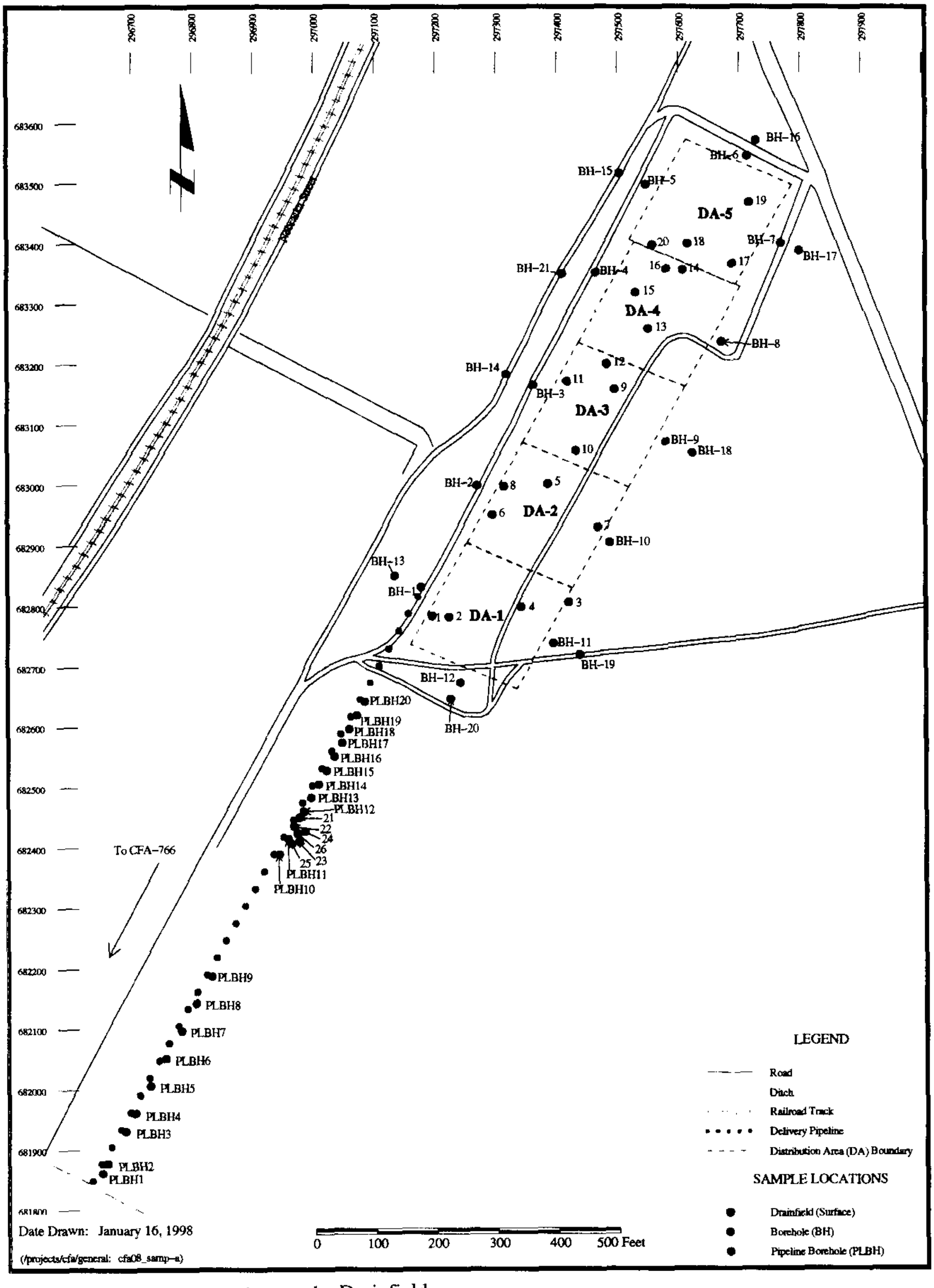


Figure 3-3. Sample locations at the Drainfield.

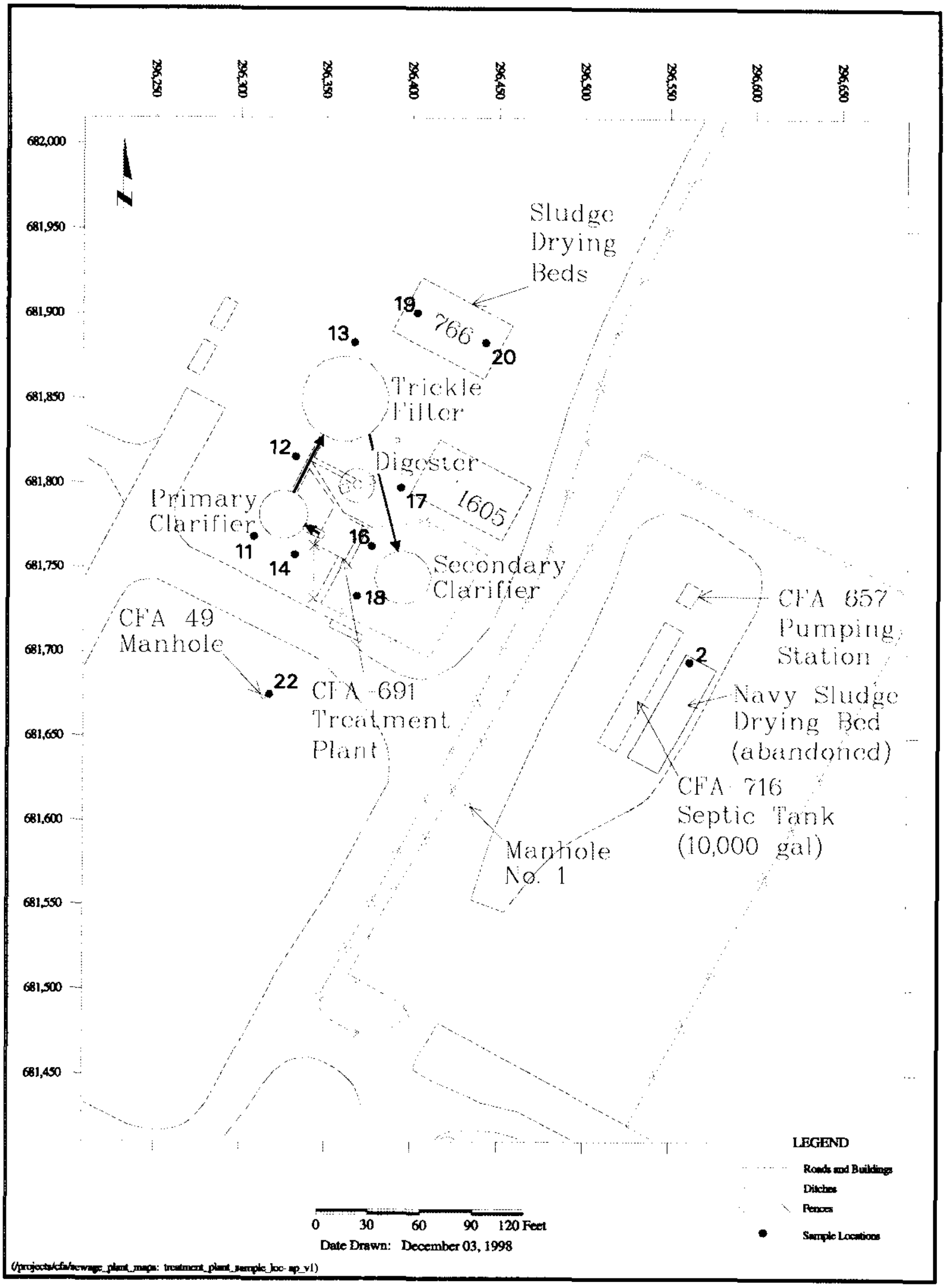


Figure 3-4. Sample locations at the CFA-08 Sewage Treatment Plant.

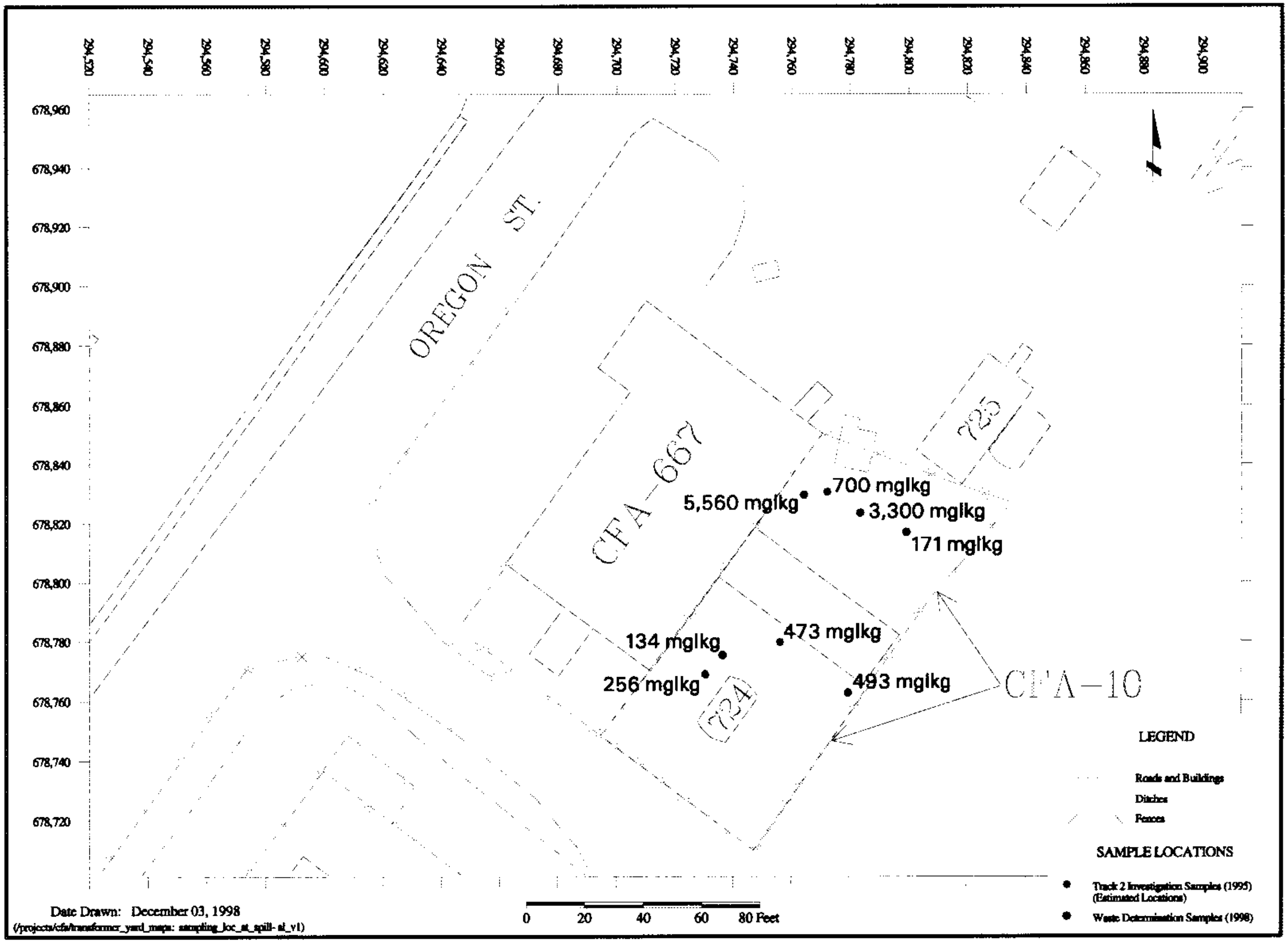


Figure 3-5. Sample locations at CFA-10 (1998).

2. Determine the waste status of lead-contaminated soil.

These objectives were met with the collection of 13 samples from 4 locations and analyzed for total lead and TCLP lead analysis. A sample was collected at depths of 0 to 0.5 ft, 1.0 ft, and 2.0 ft at each of the four locations. One duplicate sample was collected. No critical samples were identified for this sampling activity.

3.4 Miscellaneous Sites Non-time Critical Removal Action

A non-time critical removal action was conducted at the following sites in 1997: CFA-13 Drywell, CFA-15 Drywell, CFA-17/-47 Fire Department Training Area, and CFA-42 Tank Farm Pump Station Spills (DOE 1997). This action mitigated the risks identified in the Track 2 investigations at these sites (Wells 1997).

The overall objectives were to:

- Prevent exposure to radioactive materials posing future residential excess cancer risk levels (cumulative for all radioactive COCs) greater than a 10^{-6} to 10^{-4} range.
- Prevent ingestion of contaminated soils posing a total cancer risk level (cumulative for all COCs) greater than a 10^{-6} to 10^{-4} range, resulting in a total HQ greater than 1.
- Prevent inhalation of suspended radioactive materials posing excess risk levels (cumulative for all radioactive COCs) greater than a 10^{-6} to 10^{-4} range.
- Provide a mechanism for all disposition of soils at the different sites and meet all cleanup levels so that no additional remedial actions will be required at any of the sites.
- Minimize contaminated waste soils generated during soil removal activities through the use of field screening.
- Complete the project with no safety, industrial hygiene, or environmental incidents.

3.4.1 CFA-13 Dry Well (South of CFA-640)

3.4.1.1 Site Summary. This site consisted of a dry well thought to be located south of Building CFA-640. Building CFA-640 was built in 1950 and demolished in 1995, provided offices for Security and Power Management, a small area for physical fitness, a line crew craft area, an automobile repair garage, and a locomotive repair area. The dry well was not located during the Track 1 investigation and it was recommended that no further action be taken at the site. Further evidence of the dry well was discovered during demolition of the building, when a floor drain in the former garage area was discovered. The drain was connected to a buried pipe located along the outside south wall of the building. The pipe angled away from the building, where it was cut and sealed. It was believed, at that time, that this pipe may have been connected to the CFA-13 dry well and that contaminants may have been discharged to it via the floor drain. A non-time critical removal action was initiated as a result of this discovery to locate and remove the drywell.

3.4.1.2 Removal Action Activities. The area where the CFA-13 Dry Well was thought to be located was excavated along the pipe to a depth of approximately 1.8 m (6 ft) during the 1997 removal action. A structure was found and determined to be a sewer clean out box. Samples were collected from under the box and from inside the piping prior to removal of the structures in accordance with the Field Sampling Plan (FSP) (Wells, 1997). The clean out box and approximately 9 m (30 ft) of piping were removed. It was determined that the piping would be handled as asbestos piping and removal would be performed per LMITCO Management Control Procedures 2859 and 2862. The material was disposed at the CFA Bulky Waste Landfill. The excavation was backfilled, graded, and compacted. Samples were collected from the soil beneath the dry well and analyzed for radionuclides, metals, VOCs, SVOCs, and underlying hazardous constituents. The analytical data indicated that no contaminants of concern were detected above background concentrations. Analytical data from samples collected from the material in the clean out box and piping indicate no contaminants were detected above background concentrations. The objective of sample collection was to define the nature and extent of contamination and verify that all contaminants were removed from the site. The objective was fulfilled by collection of samples from locations beneath the structure and piping where contamination would have most likely occurred.

3.4.2 CFA-15 Dry Well

3.4.2.1 Site Summary. This site consisted of a dry well 0.6m (2 ft) in diameter located on the northwest side of Building CFA-674. Documentation related to the purpose of the dry well was not found during the Track 1 investigation and it was believed that no contaminants were discharged to the well. The conclusion of the Track 1 investigation was that no further action would be taken at the site. Further investigation of the nearby CFA-04 Pond determined that hazardous wastes were used in the CFA-674 Building and there was a possibility that these were discharged to the dry well. CFA-15 was included in the removal action as a result of this information.

3.4.2.2 Removal Action Activities. The soil surrounding the dry well was excavated to a depth of approximately 2.4 m (8 ft). The pipe connecting the drywell to the west wall of CFA-674 was cut and dry-packed with grout. Soil samples were collected in accordance with the FSP (Wells, 1997). Characterization data, collected from inside the dry well, indicated no radioactive contamination above INEEL background concentrations. However, INEEL procedures require that the pipe could not be released and it was therefore labeled as being potentially radiologically contaminated and buried in place. The dry well was removed and disposed at the CFA Bulky Waste Landfill. The excavation was backfilled and compacted. Soil samples were collected and analyzed for radionuclides, target analyte list, metals, VOCs, and SVOCs prior to removal of the dry well. Samples were also analyzed for underlying hazardous constituents including, TCLP metals, PCBs, herbicides, pesticides, and dioxins. Analytical data indicated no contaminants present at the drywell site above background concentrations. The objective of sample collection was to define the nature and extent of contamination and verify that all contaminants were removed from the site. The objective was fulfilled by collection of samples from locations beneath the structure and piping where contamination would have most likely occurred.

3.4.3 CFA-17 Fire Department Training Area and CFA-47 Chemical Disposal Area

3.4.3.1 Site Summary. The CFA-17 Fire Department Training Area and CFA-47 Chemical Disposal Area are located approximately 6 km (4 mi) north of CFA. The areas were used by the fire department since 1958 to train fire department personnel. The training area consisted of an asphalt pad, concrete and steel burn basins, and a drainage pond. CFA-47, located near the fire training area, is the location of terphenyl and trinitrotoluene contamination.

The non-time critical removal action was planned using data collected from the Track 2 Investigation performed in 1995. The total amount of petroleum contaminated soil removed from the site was 4,051 m^3 (5,298 yd^3) to depths ranging from 3 to 7 m (10 to 24 ft). Additional samples were collected prior to excavation of contaminated soil. Data from these samples indicated the presence of polynuclear aromatic hydrocarbons (PAHs), BTEX, arsenic, calcium, lead, mercury, silver, and terphenyl. Additional samples were collected from areas where contaminated soil was removed. The objective of sample collection was to define the nature and extent of contamination and verify that all contaminants were removed from the site. The objective was fulfilled by collection of samples from locations beneath the asphalt pad and structures where contamination would have most likely occurred. Data from the samples that indicated detections of contaminants were collected from locations directly on the basalt surface. Contaminants are likely to be present in the basalt beneath areas where detections occurred.

3.4.4 CFA-42 Tank Farm Pump Station Spills

3.4.4.1 Site Summary. This site consisted of petroleum-contaminated soil from seven above ground petroleum storage tanks, a pump station, piping, catch basins, and a fueling rack. A time-critical removal action performed in 1996 revealed extensive subsurface contamination under the fueling racks. This initial action at the site was focused on visible surface contamination at the fueling racks. Extensive subsurface petroleum contamination was discovered during this action and consequently a non-time critical removal action was performed to complete the remediation of the site.

3.4.4.2 Removal Action Activities. The objective of the time critical removal action, performed in 1996, was to remove subsurface petroleum-contaminated soil in the vicinity of the catch basins. Approximately 1,592 m^3 (2,083 yd^3) of contaminated soil was removed and treated at the CFA Landfarm. Contaminated soil was removed to the cleanup level of 1,000 mg/kg TPH. Two of the fueling racks were also removed. Evidence of additional contamination was discovered during this action, consequently, an additional non-time critical removal action was performed in 1997. Approximately 4,921 m^3 (6,437 yd^3) of contaminated soil was removed during this action. The petroleum-contaminated soil was disposed at the CFA Landfarm for treatment. All structures at the site, including the pump station, seven tanks, piping, and the fueling rack were removed and disposed. The site was filled, compacted, and regraded with clean soil. The road, which was removed, was replaced in 1998.

Seventeen boreholes were drilled at CFA-42, during the 1997 removal action, to confirm or deny the presence of petroleum hydrocarbons. Petroleum contamination was detected in several borings with one sample higher than cleanup levels. Levels used were taken from Risk-Based Corrective Action for Petroleum Sites (Idaho 1996). The contaminated sample was collected from a subsurface location between the fuel rack and pump house. The objective of sample collection was to define the nature and extent of contamination and verify that all contaminants were removed from the site. The objective was fulfilled by collection of samples from locations beneath the tanks, piping, and structures where contamination would have most likely occurred. Confirmation samples were collected in and around the pump house, fill station, and the tanks during the action. Data indicate that all contaminated soil above basalt was removed. Data from samples collected on the surface of basalt also indicate that petroleum contamination remains within basalt.

3.5 Precision and Accuracy

This section present a discussion of the precision and accuracy associated with data collected during the removal actions. Spatial variations are present in measured contaminant concentrations, creating variability in measurements. The measured concentration represents the true concentration plus the measurement error. The contribution of measurement error to the total error is assessed in this section. Analytical data from quality control samples was used to estimate accuracy and precision, quantitative estimators of measurement error, and bias.

3.5.1 Overall Precision

Precision is a measure of the reproducibility of measurements under a given set of conditions. Precision is affected by sample collection procedures at the site and the natural heterogeneity of the soil. Duplicate samples were collected at the CFA-04 Pond, CFA-08 Drainfield, and the removal action sites. The relative percent difference (RPD) was calculated for each analyte detected at CFA-04 and CFA-08 sites.

CFA-04 Pond (1997)—Six duplicate samples were collected at the CFA-04 Pond. Sample analyses included metals, nitrates, gamma spectroscopy, and uranium isotopes. The RPD for these analyses ranged from 0 to 12.5% for metals, 0.2 to 6.5% for uranium isotopes, and was 1.4% for the one nitrate analysis. All other analyses indicated non-detectable values.

CFA-04 Pond (1998)—Six duplicate samples were collected at CFA-04 in 1998. Analysis was performed for mercury. The RPD for these analyses ranged from 0 to 11.5%.

CFA-08 Drainfield—Five duplicate samples were collected at CFA-08. Sample analyses included metals, nitrates, gamma spectroscopy, and uranium isotopes. The RPD for these analyses ranged from 0 to 38.3% for metals, 3.1 to 7.8% for gamma spectroscopy, and 0 to 25% for nitrate analyses. All other analyses indicated non-detectable values.

CFA-10 (1998)—Two duplicate samples were collected at CFA-10 and analyzed for lead. The RPD for these analyses ranged from 0 to 2%.

CFA-13—One duplicate sample was collected and analyzed for radiological contaminants. The RPD for the detectable radiological constituents was 14.2% for Ra-226, 2.4% for U-234, 8.1% for U-235, and 3.6% for U 238. All other analyses indicated non-detectable values.

CFA-15—Two duplicate samples were collected and analyzed for radiological contaminants. The RPD for the detectable radiological constituents was 7.8% for Ra-226, 7.0% for U-234, 12.1% for U-235, and 3.6% for U 238. All other analyses indicated non-detectable values.

CFA-42—One duplicate sample was collected and analyzed for radiological contaminants. No compounds were detected in the analyses, consequently the RPD could not be calculated.

CFA-17/-47—Three duplicate samples were collected and analyzed for BTEX and PAH compounds. No compounds were detected in the analyses, consequently the RPD could not be calculated.

3.5.2 Overall Accuracy

Accuracy is a measure of bias in a measurement system. The field collection parameters that affect accuracy are sample preservation and handling, field contamination, and the sample matrix. The effects of the first three parameters are assessed through evaluating the field and equipment blank data. Two rinsate samples were collected at the CFA-08 Drainfield. The samples were analyzed for metals, nitrates, gamma spectroscopy, VOC, SVOC, and uranium isotopes. Two metals (calcium at 25.7 ug/L and iron at 12.9 ug/L) and U-235 (11.5 pCi/L) were detected in one of the samples. The other samples contained sodium (47.8 ug/L). All other analytical data indicated non-detectable values. These results indicate that minimal contamination of rinsate samples may have occurred from the contaminants above, however, there is no bias that would affect the intended use of the data.

3.5.3 Laboratory Precision and Accuracy

The laboratory precision and accuracy requirements are part of the validation criteria against which laboratory data are evaluated. Laboratory precision is estimated through the use of spiked samples and/or laboratory control samples. The number of laboratory QC samples are specified in the analytical methods used in the LMITCO Sample Management Office statement of work or task order. Evaluation criteria for the QC samples are specified in LMITCO SMO data validation TPRs. CLP Samples are also evaluated in accordance with this protocol.

A review of the data indicates that laboratory indicators and parameters were in control for positive detections. Some laboratory indicators and parameters were in control for "U" or "UJ" flagged data that do not affect the use of the data in the BRA. Additional information on the validation of the OU 4-13 and removal action data can be found in limitations and validations reports.

3.6 Completeness

Completeness is a measure of the quantity of usable data collected during an investigation. The completeness goal includes field sample completeness (factors such as equipment and instrument malfunctions and insufficient sample recovery) and analytical completeness, which includes factors such as damage during sample handling, shipping, packing, and storage. The QAPjP (LMITCO 1997) requires overall completeness goal of 90% for data collected during an RI/FS. If critical parameters or samples are identified, a 100% completeness goal is specified in the QAPjP.

3.6.1 OU 4-13 CFA-04 and CFA-08

The objectives for the number and locations of critical samples, identified in the SAP, at CFA-04 were met as follows:

- CFA-04 Pond; 3 randomly located samples,
- Piping from building CFA-674; 1 sample,
- Northern anomaly; all samples from locations #9 and #15, and
- Western anomaly; all samples from location #2.

The percentage of completeness for FSP planned samples is 100% (Table 3-1), which is greater than the required 90% completion. The laboratory holding period was exceeded for 14 samples collected from the western anomaly and consequently received an "r" flag. Additional samples were collected from these locations and analyzed for nitrates to replace the rejected data, which results in 100% completeness for nitrates. The "r" flagged nitrate data range in values from 0.45 to 2 mg/kg. The replacement data rage in values from 0.6 to 90 mg/kg, which is an order of magnitude higher.

The objectives for the number and locations of critical samples collected at CFA-08 were met with the collection of the required number of critical samples from the drainfield. The following number of analyses were required for these samples; arsenic–3 samples, Cs-137–6 samples, and U-238–13 samples. The percentage of overall completeness for FSP planned samples is 100%.

Table 3-1.

	Inorganic				Organic					Radiological									
Completeness	Metals	As	Hg	Nitrate	VOA	SVOA	PCB	PAH	TPH	All	^{137}Cs	^{234}U	^{235}U	^{238}U	^{241}Am	^{60}Co	$^{152/154}$Eu	$^{239/240}$Pu	^{90}Sr
CFA-04 Pond (OU 4-13—1997)																			
Samples	29	95	136	44	18	14	9			17	25	46	69	46					
Acceptable Data	29	95	136	44	18	14	9			17	25	46	69	46					
% Complete	100%	100%	100%	100%	100%	100%	100%			100%	100%	100%	100%	100%					
CFA-04 Pond OU 4-13 RI/FS—1998																			
Samples			91																
Acceptable Data			91																
% Complete			100%																
CFA-08 Drainfield (Mercury Retort Staging Area)																			
Samples	48																		
Acceptable Data	48																		
% Complete	100%																		
CFA-08 Drainfield																			
Samples	31			51		28	28				65	32	81	33	75	63	49	27	
Acceptable Data	31			51		28	28				65	32	81	33	75	63	49	27	
% Complete	100%			100%		100%	100%				100%	100%	100%	100%	100%	100%	100%	100%	
CFA-08 Pipeline																			
Samples	10			28			10			3			6						28
Acceptable Data	10			28			10			3			6						28
% Complete	100%			100%			100%			100%			100%						100%
CFA-08 Sewage Treatment Plant																			
Samples	12			51		8	8			13			26		26				
Acceptable Data	12			51		8	8			13			26		26				
% Complete	100%			100%		100%	100%			100%			100%		100%				

Table 3-1. (continued).

	Inorganic				Organic					Radiological									
Completeness	Metals	As	Hg	Nitrate	VOA	SVOA	PCB	PAH	TPH	All	^{137}Cs	^{234}U	^{235}U	^{238}U	^{241}Am	^{60}Co	$^{152/154}Eu$	$^{239/240}Pu$	^{90}Sr
CFA-10 Yard (1997 and 1998)																			
Samples	15						6												
Acceptable Data	15						6												
% Complete	100%						100%												
CFA-13 Drywell																			
Samples	6				10		2	6		7			14		14				
Acceptable Data	6				10		2	6		7			14		14				
% Complete	100%				100%		100%	100%		100%			100%		100%				
CFA-15 Drywell																			
Samples	6				5	6	2	6		6			12		12				
Acceptable Data	6				5	6	2	6		6			12		12				
% Complete	100%				100%	100%	100%	100%		100%			100%		100%				
CFA-17/-47 Fire Station																			
Samples					32			43											
Acceptable Data					32			43											
% Complete					100%			100%											
CFA-26 Spill																			
Samples					6	6			6										
Acceptable Data					6	6			6										
% Complete					100%	100%			100%										
CFA-42 Tank Farm																			
Samples					40			42											
Acceptable Data					40			42											
% Complete					100%			100%											

3.6.2 Non-time Critical Removal Actions (1997)

Sampling was performed during the Non-time critical removal action at the CFA-13 Drywell, CFA-15 Drywell, CFA-42 Tank Farm, and CFA-17/-47 Fire Department Training Area.

CFA-13 Drywell. Samples were collected and analyzed for radionuclides, metals, VOCs, SVOCs. The percentage of completeness for FSP planned samples is 100%. Data from these samples indicated that no contaminants were detected above background concentrations. The analyses for all samples resulted in acceptable data with the following exceptions. Data considered unusable (flagged "r") included the following analytes in the VOC analysis (acrylamide, idomethane, isobutyl alcohol, N-butanol) due to failure to meet minimum laboratory requirements for instrument calibration.

CFA-15 Drywell. Samples were collected and analyzed for radionuclides, metals, PAHs, VOCs, SVOCs, herbicides, and pesticides. The percentage of completeness for FSP planned samples ranges from 78 to 100 percent, which is less than the required 90% (Table 3-1). The full set of planned samples were not collected during the action because data from samples collected prior to the excavation indicated no contamination. The number of planned samples was determined assuming that contaminants would be present in and around the drywell, consequently, fewer samples were collected Analytical data considered unusable (flagged "r") included the following analytes in the VOC analyses (acrolein, idomethane, isobutyl alcohol, N-butanol) due to failure to meet minimum laboratory requirements for instrument calibration.

CFA-42 Tank Farm Pump Station Spills. Samples were collected and analyzed for benzene, toluene, ethylbenzene, xylene (BTEX), and PAHs. The percentage of completeness for FSP planned samples ranges is 100%.

CFA-17/-47 Fire Station. Samples were collected and analyzed for BTEX and PAHs. The percentage of completeness for FSP planned samples 100 percent.

3.6.3 Detection Limits

The analytical data from these investigations are used in Section 6 to complete a BRA and characterize the type and extent of contamination. Acceptable detection limits for organic compounds are based on regulatory or risk-based levels. The laboratory reports all positive results for analyzed compounds even if they are less than the Contract Required Quantitation Limit (CRQL). Unless the results are rejected as unusable during data validation, all results are used to characterize the nature and extent of contamination and the risk. Compounds that are detected below the CRQL are estimated values and are generally flagged "J". CRQLs are chemical and sample matrix-specific concentrations that a laboratory must be able to routinely and reliably detect and quantify when using the analytical method specified in the CLP SOWs. Analytical data with validation flags attached are contained in Appendix B.

3.7 Comparability and Representativeness

Comparability is the confidence with which one data set can be compared to another. Data comparability is a qualitative characteristic that is achieved using standard field and analytical methods and procedures related to the areas discussed below. Field collection and sampling handling methods used at OU 4-13 and removal action sites was conducted in accordance with the procedures and requirements in the QAPjP (LMITCO 1997) and the FSPs. Field and laboratory QA/QC procedures were consistent in both the OU 4-13 and removal actions. Data collected at these sites is therefore comparable for the purpose of the BRA.

Representativeness is a qualitative parameter that expresses the degree to which the analytical data reflect the characteristics being measured. Representativeness is best evaluated by comparing the number of samples collected to the number necessary to be representative and by confirming that the sample locations were properly located. The required number of samples were collected at CFA-04 and CFA-08 for these data to be considered representative of the conditions present at these sites. The location of all samples was documented in the topographic survey.

Data collected at the removal action sites is also considered to be representative of clean site conditions after contamination was removed. The extent of contamination in the vadose zone above basalt was determined by removal of contaminated soil and subsequent sample collection in undisturbed soil. Samples were collected from biased locations where contaminants would be expected to be present, based on known contamination areas.

3.8 References

Blackmore, C. S., 1997a, *Field Sampling Plan for Operable Unit 4-13 Central Facilities Area,* INEL-96/0315, March.

DOE, 1997, *Engineering Evaluation/Cost Analysis for WAG 4 Miscellaneous Sites 1997 Non-Time-Critical Removal Action (CFA-13, -15, -17, -47, and –42)*, DOE/ID-10582, May.

Idaho, 1996, *Risk Based Corrective Action Guidance Document for Petroleum Release Sites*, Division of Environmental Quality Remediation Bureau, August.

LMITCO, 1997, *Quality Assurance Project Plan for Waste Area Groups 1, 2, 3, 4, 5, 6, 7, 10 and Inactive Sites*, DOE/ID-10587, Revision 5, December.

Stormberg, G. J., Haney, D. F., 1996, *Limited Scope and Characterization Plan for the CFA Sewage Treatment Plant,* INEL-96/0331, September.

Wells, R. P., 1997, *Field Sampling Plan for the WAG 4 Miscellaneous Sites 1997 Non-Time-Critical Removal Action (CFA-13, -15, -17, -47, and –42),* DOE/ID-10583, Revision 0, May.